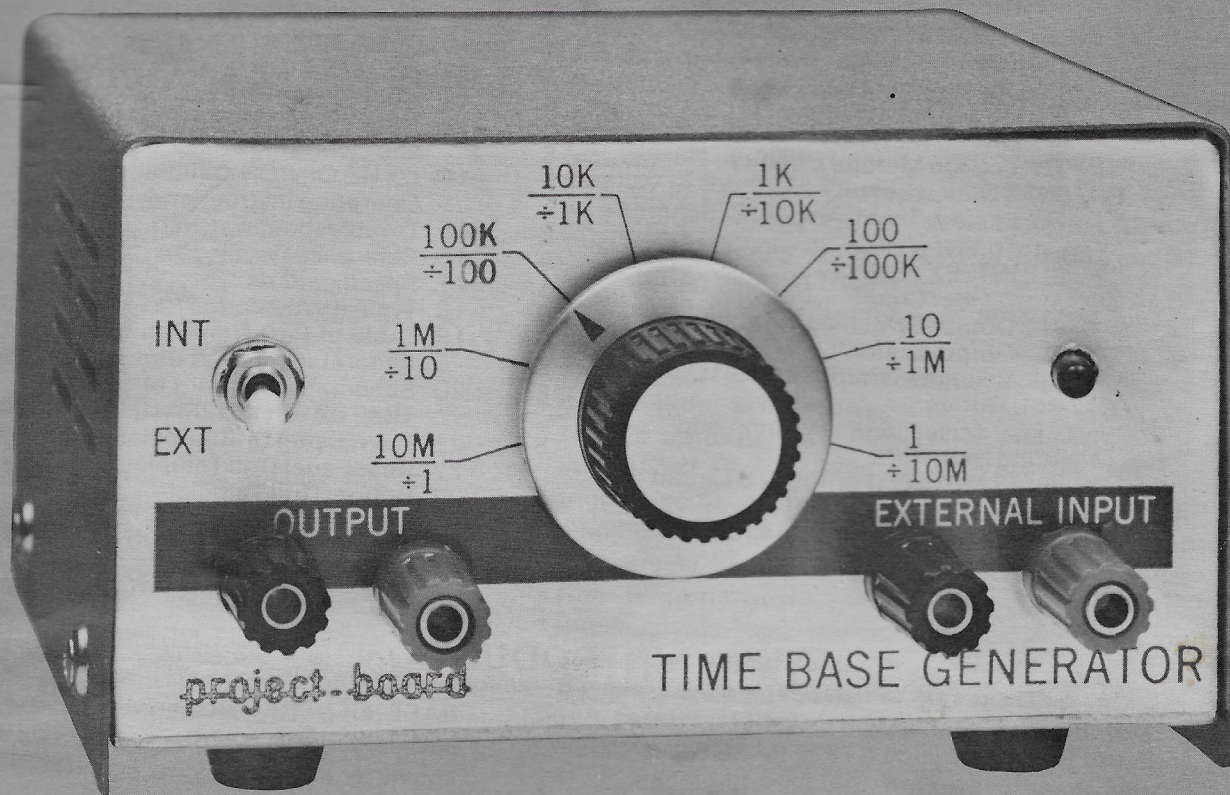


TIME BASE GENERATOR

project-board®



CATALOG NUMBER 277-115

This PROJECT BOARD TIME BASE GENERATOR utilizes TTL logic. It provides stable, precise frequency standards. The TIME BASE GENERATOR may be used for oscilloscope calibration, sine wave to square wave conversion and digital signal sources.

Photograph is the completed project when built with the recommended Radio Shack parts. This package contains only the Printed Circuit Board, Front and Rear Panel Labels and instructions. Assembly instructions are provided for optional units -- which are, a Line Frequency Counter/Divider and a Binary Coded Decimal Counter.

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INTRODUCTION

This package contains a complete Printed Circuit Board for constructing a TIME BASE GENERATOR. It also contains the front and back panel labels.

The Instruction Manual gives you a complete list of parts needed to complete your project. It also gives you theory of operation, calibration and operating instructions, a troubleshooting chart, diagrams and photographs to aid you in your project.

The Project Board (Printed Circuit Board) is highly versatile with several options. Three options will be presented in the instruction manual. Any deviation from these options will be at the user's own discretion and ingenuity. The three options are as follows:

1. SYMMETRICAL DIVIDE-BY-TEN COUNTER/DIVIDER (TIME BASE OPTION)
2. LINE FREQUENCY COUNTER/DIVIDER (60 HZ OPTION)
3. BINARY CODED DECIMAL COUNTER (BCD OPTION)

The TIME BASE OPTION will give the user the maximum flexibility of this Project Board. Once constructed, the TIME BASE OPTION of the TIME

BASE GENERATOR can be used as a frequency standard, scope calibrator, sine wave to square wave converter and/or a digital signal source. The internal crystal oscillator and divider chain enables the user to select a stable precise frequency from 10 MHz to 1 Hz in succession of 10's. These precise frequencies can be used to check and calibrate the horizontal sections of an oscilloscope. The fast rise and fall times of these square waves can be used to adjust frequency compensated probes. This option can also be used with an external variable sine wave oscillator to provide a variable square wave compatible with TTL circuits. The unit can be used as a TTL signal source using either the internal crystal oscillator or external signal source.

The 60 Hz OPTION, when constructed, will provide the user with a 10 Hz, 1 Hz, and 0.1 Hz square wave. These square waves use the line frequency as their reference. This option can be used as a reference frequency for digital design and experimenting.

The final option discussed in this Instruction Manual will be the BCD OPTION. This option uses only the divider chain portion of the Project Board. The divider chain is wired so that the type 7490 IC's operate as BCD counters. This option is presented as one example of several possible applications for the 277-115 Printed Circuit Board.

THEORY OF OPERATION

TIME BASE OPTION

Refer to Figure 1, Block Diagram, and to Figure 26, Schematic Diagram of TIME BASE GENERATOR while you read the theory of operation. The Block Diagram shows the seven circuit blocks of the TIME BASE OPTION. The seven circuit blocks described are:

1. Limiter/Input Amplifier/Schmitt Trigger.
2. Crystal Oscillator.
3. INT/EXT Select.
4. Divider Chain.
5. Output Switching.
6. Output Buffer.
7. Voltage Monitor Circuits.

Limiter/Input Amplifier/Schmitt Trigger. When an input signal is applied to the EXTERNAL INPUT jacks, C9 decouples any DC voltage that may be present and couples any AC voltage to the junction of C8, R16 and R17. Resistor R17 sets the input impedance at one megohm. Resistor R16 provides current limiting for CR2 and CR3 while C8 provides frequency compensation for higher frequencies.

Diodes CR2 and CR3 will clamp any input signal that tries to rise above 1.2V peak-to-peak on the gate of

Q4. Transistors Q3 and Q4 provide a high input impedance and a low output impedance with a gain of approximately 1. Potentiometer R14 is adjusted to compensate for variation in the saturation current (I_{loss}) of Q4 and to set the DC operating point of the entire input amplifier and Schmitt Trigger. Transistor Q2 is a common emitter amplifier with a gain of approximately 5. Inductor L1 and capacitors C2 and C4 provide power supply decoupling to insure stability of the input amplifier. Transistor Q1 serves as a common collector amplifier for buffering Q2 into the Schmitt Trigger. Gates C and D of IC8, CR1 and R1 make up the Schmitt Trigger. The Schmitt Trigger has a turn-on voltage of 2 volts and a hysteresis voltage of 0.6 volt. When an input signal coupled from the emitter of Q1 crosses the 2 volt turn-on voltage, the output of the Schmitt Trigger fires high and will not change states until the input signal drops below 1.4 volt. Once R14 is properly adjusted to just below the trigger point of the Schmitt Trigger, the input amplifier will be immune to noise or other undesirable signal components which do not exceed the trigger point, while providing sharp, unambiguous logic transitions for signals that do exceed the trigger point. The output of the Schmitt Trigger is coupled to pin 1 of gate A of IC8, which is part of the INT/EXT select circuitry.

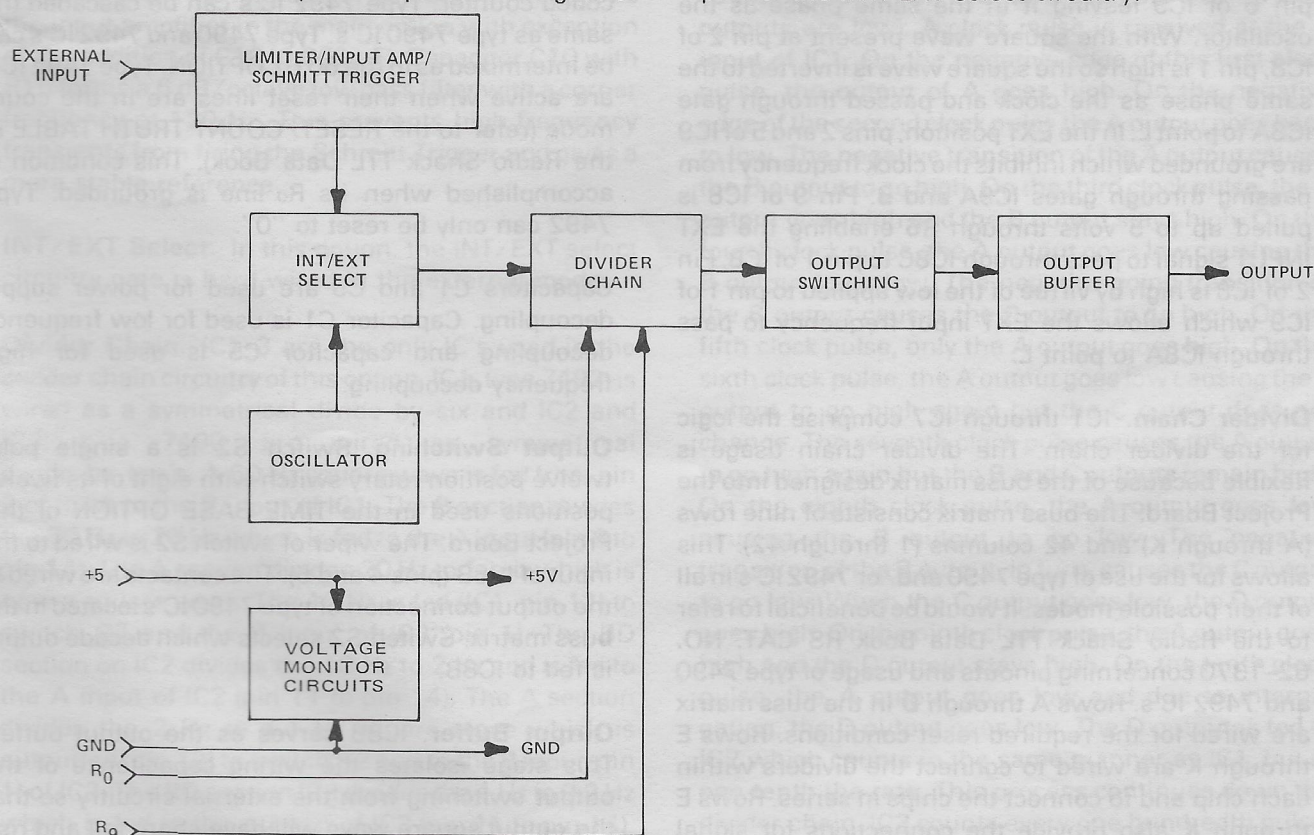


Figure 1. Block Diagram

Crystal Oscillator. Crystal Y1 and Gates C and D of IC9 form a 10MHz oscillator. Resistors R8, R9, R10, R11 and R12 bias the gates into their linear regions and insure start up. Capacitors C6 and C7 provide proper capacitive loading for Y1. The two gates give 360° phase from input of one to output of the other. Crystal Y1 controls the proper 360° phase shift at 10 MHz. The output of the oscillator (pin 11, IC9D) is fed to pin 1 of IC9A, which serves as a portion of the AND-OR invert gate. IC9A also buffers the oscillator from the divider chain.

INT/EXT Select. The INT/EXT select circuit consists of switch S1, resistors R6 and R7 and the AND-OR invert gate. The AND-OR invert gate is equivalent of a single pole double throw switch with point L being the wiper and the external input and crystal oscillator being the two contacts. Gates A and C of IC8 and gate A of IC9 form the AND-OR invert gate. Pin 2 of IC9 and pin 9 of IC8 are both pulled up to 5 volts. The INT-EXT switch selects the desired mode by grounding the opposite mode. If the INT mode is selected, pin 9 of IC8 is grounded causing a high at pins 1 and 8 of IC8 regardless of the logic level at pin 10 of IC8. Pins 2 and 5 of IC9 are pulled up to 5 volts through R7. This enables the oscillator square wave to pass through gates A and B of IC9. The square wave is inverted at pin 3 of IC9 and inverted again at pin 6 of IC9 leaving it in the same phase as the oscillator. With the square wave present at pin 2 of IC8, pin 1 is high so the square wave is inverted to the same phase as the clock and passed through gate IC8A to point L. In the EXT position, pins 2 and 5 of IC9 are grounded which inhibits the clock frequency from passing through gates IC9A and B. Pin 9 of IC8 is pulled up to 5 volts through R6 enabling the EXT INPUT signal to pass through IC8C to pin 1 of IC8. Pin 2 of IC8 is high by virtue of the low applied to pin 1 of IC9 which allows the EXT input frequency to pass through IC8A to point L.

Divider Chain. IC1 through IC7 comprise the logic for the divider chain. The divider chain usage is flexible because of the buss matrix designed into the Project Board. The buss matrix consists of nine rows (A through K) and 42 columns (1 through 42). This allows for the use of type 7490 and/or 7492 IC's in all of their possible modes. It would be beneficial to refer to the Radio Shack TTL Data Book RS CAT. NO. 62-1370 concerning pinouts and usage of type 7490 and 7492 IC's. Rows A through D in the buss matrix are wired for the required reset conditions. Rows E through K are wired to connect the dividers within each chip and to connect the chips in series. Rows E through K also provide the connections for signal output. Type 7490 IC's can be wired as a binary coded decimal decade counter (BCD discussed in a later

section), symmetrical divide-by-ten counter, a divide-by-two counter or a divide-by-five counter. The TIME BASE OPTION of the Project Board is wired as a symmetrical divide-by-ten counter. In this option the type 7490 IC's are wired so that any digital signal from point L is fed into the B input (pin 1) IC1. The BD section of IC1 divides the signal frequency by five. This signal is then fed to the A input of IC1 (pin 12 to pin 14). The A section divides the signal by two which completes the divide-by-ten process of IC1. This signal is then fed to the B input of IC2 where the same division process is done as in IC1. This division process is repeated successively for all the counters. If you apply a 10 MHz signal to the B input of IC1, the output from IC1 will be 1 MHz and is coupled to the B input of IC2. IC2 divides 1 MHz to 100 kHz and couples the 100 kHz to IC3. The process continues down the divider chain to IC7 which outputs a 1Hz signal. IC1 through 7 are active while their reset lines are in the count mode (refer to the RESET/COUNT TRUTH TABLE in the Radio Shack TTL Data Book). This condition is achieved when the R₀ and R₉ lines are grounded. Type 7490 IC's can be reset to either "0" or "9".

Type 7492 IC's provide divide-by-two, divide-by-three, divide-by-six and divide-by-twelve functions. Type 7492 cannot be used as a binary coded counter. Type 7492 IC's can be cascaded the same as type 7490 IC's. Type 7490 and 7492 IC's can be intermixed as in the 60 HZ OPTION. Type 7492 IC's are active when their reset lines are in the count mode (refer to the RESET/COUNT TRUTH TABLE in the Radio Shack TTL Data Book). This condition is accomplished when its R₀ line is grounded. Type 7492 can only be reset to "0".

Capacitors C1 and C5 are used for power supply decoupling. Capacitor C1 is used for low frequency decoupling and capacitor C5 is used for high frequency decoupling.

Output Switching. Switch S2 is a single pole, twelve position rotary switch with eight of its twelve positions used in the TIME BASE OPTION of this Project Board. The wiper of switch S2 is wired to the input of IC8B (pins 4 and 5). The contacts are wired to the output connection of type 7490 IC's located in the buss matrix. Switch S2 selects which decade output is fed to IC8B.

Output Buffer. IC8B serves as the output buffer. This stage isolates the wiring capacitance of the output switching from the external circuitry so that the output square wave will have sharp fall and rise times. The output buffer also guarantees a fan-out of 10 (it will drive ten TTL loads).

Voltage Monitor Circuits. Fuse F1 and Zener diode CR4 comprise the over-voltage protection circuit. This circuit is designed to protect the semiconductor components from an over-voltage condition (6.2 volts or greater).

If the input voltage rises above 6.2 volts, diode CR4 will react as a direct short to ground which will cause fuse F1 to open, thereby removing all operating voltage from the Printed Circuit Board.

Resistor R18 and Light Emitting Diode (LED) provide the power on indicator circuits. LED (DS1) provides the power-on indication and resistor R18 serves as the current limiting element for protection of the LED.

60 HZ OPTION

Refer to the previous theory of operation, block diagram and schematic diagram while reading this theory.

Limiter/Input Amplifier/Schmitt Trigger. This option uses the line frequency as its frequency standard. The 60 Hz signal is applied to the external input of the TIME BASE GENERATOR where the Limiter/Input Amplifier/Schmitt Trigger converts the 60 Hz sine wave to a 60 Hz square wave. The input amplifier in this option operates the same as the input amplifier in the main option with exception of the addition of C10 (0.005 μ F). Capacitor C10 with R16 forms a 6 dB/octave low pass filter with a corner frequency at 120 Hz. This prevents high frequency transients from firing the Schmitt Trigger and gives a more stable reference.

INT/EXT Select. In this option, the INT/EXT select circuitry gate is hard wired in the external mode.

Divider Chain. IC1-3 are the only IC's used in the divider chain circuitry of this option. IC1, type 7492, is wired as a symmetrical divide-by-six and IC2 and IC3, type 7490, are wired as symmetrical divide-by-ten's. A 60 Hz square wave is fed from pin 3 of IC8A to the B input of IC1. The B section divides the 60 Hz to 20 Hz which is fed to the A input (pin 9 to pin 14). The A section divides 20 Hz to 10 Hz which is now a square wave. The 10 Hz is fed (IC1, pin 12) to switch S2 and the B input of IC2 (pin 1). The BD section on IC2 divides the 10 Hz to 2 Hz and is fed to the A input of IC2 (pin 11 to pin 14). The A section divides the 2 Hz to a 1 Hz square wave which is outputted (pin 12) to switch S2 and to the B input (pin 1) of IC3. The BD section IC3 divides the 1 Hz to 0.2 Hz which is fed to the A input of IC3 (pin 11 to pin 14). The A section of IC3 divides the 0.2 Hz to a 0.1 Hz square wave which is connected to switch S2.

Output Switching. Switch S2 is used in the same fashion as in the TIME BASE OPTION except only three contacts are used. Switch S2 selects the 10 Hz, 1 Hz and 0.1 Hz square waves from IC1, pin 3.

Output Buffer. The Output Buffer functions the same as in the TIME BASE OPTION.

Voltage Monitor Circuits. The voltage monitor circuits in the 60 HZ OPTION operate the same as in the TIME BASE OPTION.

BCD OPTION

The binary coded decimal decade counter wiring of type 7490 IC's differs somewhat from their wiring in the symmetrical-divide-by-ten counter. A digital signal is coupled from point L on the Project Board to the A input of IC1 (pin 14). The A output is fed to the B input (pin 12 to pin 1). The D output is fed to the next decade, IC2. IC2 performs the same function as IC1 and couples its output to IC3. The same process continues down the divider chain (refer to the BCD COUNT SEQUENCE table in the Radio Shack TTL Data Book). Each decade is an asynchronous 1-2-4-8 BCD counter.

Let's take a look at how these counters actually count. Assume all counters are reset to "0" (all outputs are low). A clock pulse is received at the A input of IC1. On the negative edge of this first clock pulse, the output of A goes high. On the negative edge of the second clock pulse the A output goes back to low. The negative transition of the A output causes the B output to go high. On the third clock pulse, the A output goes high and the B output stays high. On the fourth clock pulse, the A output goes low causing the B output to go low. The negative going transition of the B output causes the C output to go high. On the fifth clock pulse, only the A output goes high. On the sixth clock pulse, the A output goes low causing the B output to go high again but the C output does not change. The seventh clock pulse causes the A output to go high again but the B and C outputs remain high. On the eighth clock pulse, the A output goes low causing the B output to go low. The negative transition of the B output, in turn, causes the C output to go low. When the C output goes low, the D output goes high. On the ninth clock pulse, the A output goes high and the D output stays high. On the tenth clock pulse, the A output goes low and due to internal gating, the D output goes low. The D output is fed to IC2 which counts in the same manner as IC1, but at one tenth the rate. This process continues down the divider chain. IC3 counts every one hundredth pulse, IC4 counts every one thousandth pulse and so on.

It can be seen that in respect to magnitude, IC7 is the 10^6 decade, IC6 is the 10^5 decade, IC5 is the 10^4 decade and so on to IC1 which is the 10^0 (units) decade. Suppose we put 7,654,321 pulses into the

input of IC1 from reset to "0". The BDC output of all the counters would appear as shown in the following table:

IC	IC7	IC6	IC5	IC4	IC3	IC2	IC1
POWER OF TEN	10^6	10^5	10^4	10^3	10^2	10^1	10^0
OUTPUT	DCBA	DCBA	DCBA	DCBA	DCBA	DCBA	DCBA
BCD COUNT	0111	1010	1001	0100	0011	0010	0001
DECIMAL COUNT	7	6	5	4	3	2	1

PARTS LIST, MISCELLANEOUS ITEMS AND MOUNTING HARDWARE

Unless you substitute parts by your own decision, no parts other than those listed in these instructions are needed to build any one of the Project Board options.

The following PARTS LIST charts the quantity and types of parts required for the previously described options. You will note that only a portion of the parts listed are required to build the 60 Hz OPTION. Also that a lesser portion of the parts listed are required to build the BCD OPTION.

Also listed herein are MISCELLANEOUS ITEMS and RECOMMENDED MOUNTING HARDWARE. Under RECOMMENDED MOUNTING HARDWARE, IC sockets are listed as optional items; however their use further increases the versatility of your Project Board. When sockets are used, IC's can be easily removed and replaced without the need for unsoldering their leads. You'll readily realize the advantage of their use when you begin building circuits of your own design.

Note that the TIME BASE OPTION may be operated strictly from an external frequency source if one does not wish to utilize an internal crystal.

PARTS LIST

SYMBOL	DESCRIPTION	RADIO SHACK CAT.#	PARTS QUANTITY PER OPTION		
			TIME BASE OPTION	60 HZ OPTION	BCD OPTION
C1	Capacitor, $10\mu\text{F}$, Electrolytic axial 35V	272-1013	1	1	1
C2	Capacitor, $0.01\mu\text{F}$, Ceramic disc	272-131	1	1	
C3	Capacitor, $0.005\mu\text{F}$, Ceramic disc	272-130	1		
C4, C5	Capacitor, $0.1\mu\text{F}$, Ceramic disc	272-135	2	2	1
*C6, *C7	Capacitor, 47 pF, Ceramic disc	272-121	2		
C8	Capacitor, 5 pF, Ceramic disc	272-120	1		
C9	Capacitor, $0.47\mu\text{F}$, Tubular 250WVDC	272-1054	1	1	
C10	Capacitor, $0.005\mu\text{F}$, Ceramic disc	272-130		1	
CR1-CR3, CR5	Diode, silicon, 1N914	276-1122	4	4	
CR4	Diode, Zener 6.2V	276-561	1	1	
DS1	Jumbo red LED, 1.75V @ 20 mA	276-041	1	1	
F1	Fuse, 1/2 amp, fast-acting	270-1271	1	1	
Fuseholder	In-line fuse holder	270-1281	1	1	

SYMBOL	DESCRIPTION	RADIO SHACK CAT.#	PARTS QUANTITY PER OPTION		
			TIME BASE OPTION	60 HZ OPTION	BCD OPTION
IC1-7	Decade counter, RS 7490	276-1808	7 5	2	7
IC1	Divide-by-twelve counter, RS 7492	276-1819		1	
IC8, *9	NAND gate, RS 7400	276-1801	2	1	
J1-J4	Five way binding post	274-662	4	4	
L1	R.F. choke, 0.01 MH (10 μ H)	273-101	1	1	
PCB1	Time base generator/divider PC board	277-115	1	1	1
Q1-Q2	Transistor, NPN RS2011, RF/IF amp and osc	276-2011	2	2	
Q3	Transistor, PNP RS2021	276-2021	1	1	
Q4	Transistor, FET RF amplifier, RS2036	276-2036	1	1	
	NOTE: EXCEPT FOR R16 AND POTENTIOMETER R14, 1/4W, 5% RESISTORS RS CAT. NO. 271-1300 MAY BE SUBSTI- TUTED FOR THE 1/2W, 10% RESISTORS.				
R1	Resistor, 270 Ohm 1/2W, 10% (RED, VIOLET, BROWN)	271-000	1	1	
R2, *R10, *R12	Resistor, 220 Ohm, 1/2W, 10% (RED, RED, BROWN)	271-000	3	1	
R3	Resistor, 680 Ohm, 1/2W, 10% (BLUE, GRAY, BROWN)	271-000	1	1	
R4, R5	Resistor, 100 Ohm, 1/2W, 10% (BROWN, BLACK, BROWN)	271-000	2	2	
R6	Resistor, 4.7K, 1/2W, 10% (YELLOW, VIOLET, RED)	271-000	1	1	
R7	Resistor, 2.2K, 1/2W, 10% (RED, RED, RED)	271-000	1	1	
*R8	Resistor, 1.8K, 1/2W, 10% (BROWN, GRAY, RED)	271-000	1		
*R9	Resistor, 1K, 1/2W, 10% (BROWN, BLACK, RED)	271-000	1		
*R11	Resistor, 560 Ohm, 1/2W, 10% (GREEN, BLUE, BROWN)	271-000	1		
R13	Resistor, 68 Ohm, 1/2W, 10% (BLUE, GRAY, BLACK)	271-000	1	1	
R14	Potentiometer, P.C. 2.5K, 1/4W	271-228	1	1	
R15, R18	Resistor, 180 Ohm, 1/2W, 10% (BROWN, GRAY, BROWN)	271-000	2	2	
R16	Resistor, 100K, 1/2W, 10% (BROWN, BLACK, YELLOW)	271-000	1	1	
R17	Resistor, 1M, 1/2W, 10% (BROWN, BLACK, GREEN)	271-000	1	1	
S1	Switch, subminiature, SPDT	275-326	1		
S2	Switch, rotary, SP12T	275-1385	1	1	
TB1	Screw terminal strip (4 terminal)	274-665	1	1	
Y1	10MHz crystal	**	1		
Cabinet	Metal cabinet 5 1/4 x 3 x 5 7/8" (13.34 x 7.62 x 14.92 cm)	270-253	1	1	

* Parts needed with Y1.

** Available from TANDY CRYSTAL CENTER through your Radio Shack Store.

MISCELLANEOUS ITEMS

SYMBOL	DESCRIPTION	RADIO SHACK CAT.#	PARTS QUANTITY PER OPTION		
			TIME BASE OPTION	60 HZ OPTION	BCD OPTION
Wire	22 gauge, hookup wire stranded	278-1307	1 pkg	1 pkg	1 pkg
Wire	24 gauge, shielded cable	278-1277	1 pkg	1 pkg	
Wire	22 gauge, hookup wire, solid	278-1295	1 pkg	1 pkg	1 pkg
Solder	20 gauge	64-006	1 spool	1 spool	1 spool

RECOMMENDED MOUNTING HARDWARE

SYMBOL	DESCRIPTION	RADIO SHACK CAT.#	PARTS QUANTITY PER OPTION		
			TIME BASE OPTION	60 HZ OPTION	BCD OPTION
Screws	4-40 x 1/4" (0.64 cm), 1/2" (1.27 cm), 3/4" (1.91 cm)	64-3011	1 pkg	1 pkg	
Washers	Flat steel washers	64-3022	1 pkg	1 pkg	
Nuts	4-40 hex steel machine nuts	64-3018	1 pkg	1 pkg	
Knob	Single-line index communication knob	274-391	1 pkg	1 pkg	
Spacers	Assorted aluminum spacers	270-1393	1 pkg	1 pkg	
*Socket	Standard, 14-pin	276-027	*5 pkg	*2 pkg	*4 pkg
*Optional item for mounting IC's.					

MOUNTING OF PARTS

The following steps are the recommended sequence for mounting of parts to the Project Board. Refer to Figure 2, TIME BASE OPTION Resistor Installation or Figure 3, 60 HZ OPTION Resistor Installation for parts

location. Boxes under column headings show parts required for each option. A box under a column heading means that the part listed in the left hand column is used on that option. Check the box ☒ when you have performed the step.

Mount the following resistors:

TIME BASE OPTION

60 HZ OPTION

- | | | |
|---|-------------------------------------|--------------------------|
| R1, 270 ohm (red, violet, brown) | ☒ | ☐ |
| R2, 220 ohm (red, red, brown) | ☒ | ☐ |
| R3, 680 ohm (blue, gray, brown) | ☒ | ☐ |
| R4, 100 ohm (brown, black, brown) | ☒ | ☐ |
| R5, 100 ohm (brown, black, brown) | ☒ | ☐ |
| R6, 4.7K (yellow, violet, red) | ☒ | ☐ |
| R7, 2.2K (red, red, red) | ☒ | ☐ |
| ☐ Turn the board over and solder leads to the foil. Trim off excess lead length. | | |
| *R8, 1.8K (brown, gray, red) | ☒ | |
| *R9, 1K (brown, black, red) | ☒ | |
| *R10, 220 ohm (red, red, brown) | ☒ | |
| *R11, 560 ohm (green, blue, brown) | ☒ | |
| *R12, 220 ohm (red, red, brown) | ☒ | |
| ☐ Turn the board over and solder leads to the foil. Trim off excess lead length. | | |

TIME BASE OPTION

60 HZ OPTION

R13, 68 ohm (blue, gray, black)	☒	☐
R15, 180 ohm (brown, gray, brown)	☒	☐
R16, 100K (brown, black, yellow)	☒	☐
R17, 1M (brown, black, green)	☒	☐
R18, 180 ohm (brown, gray, brown)	☒	☐

☒ Turn the board over and solder. Trim off excess lead length.

*Identifies parts directly associated with crystal Y1. If you use an external frequency source instead of crystal Y1, these parts are not needed.

NOTE: A word of warning right at the beginning -- if you run into problems when you're done (we hope you won't ... but if you do ...) 9 times out of 10 it will be because of poor soldering. Also watch for proper parts identification and installation.

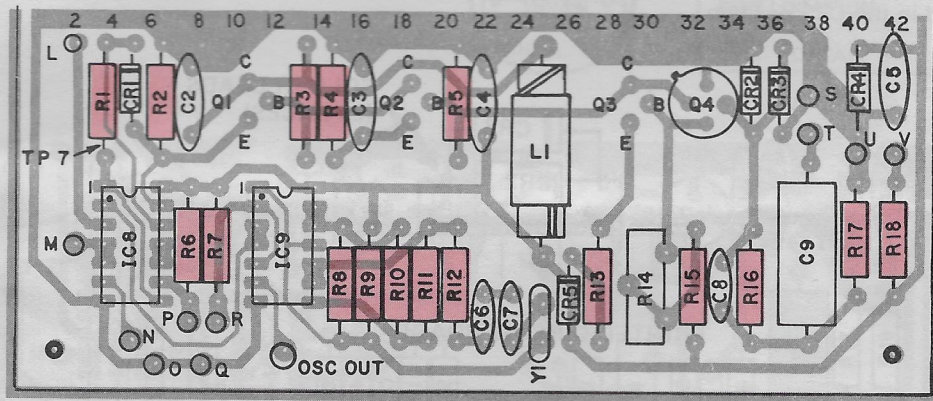


Figure 2. TIME BASE OPTION Resistor Installation Diagram

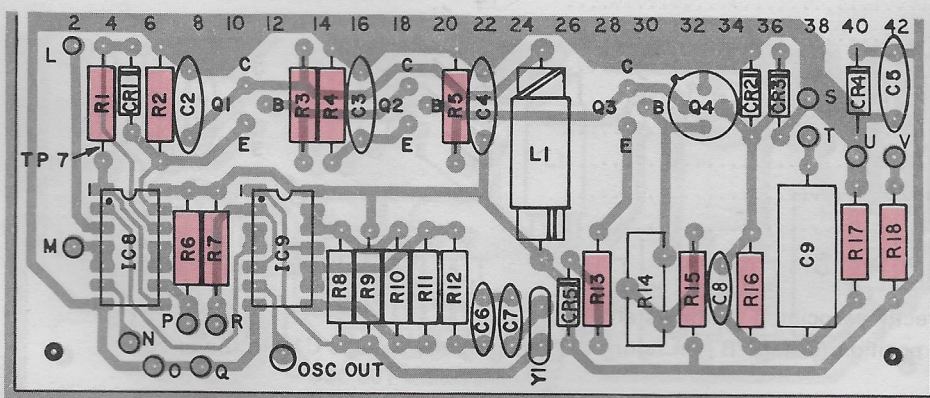
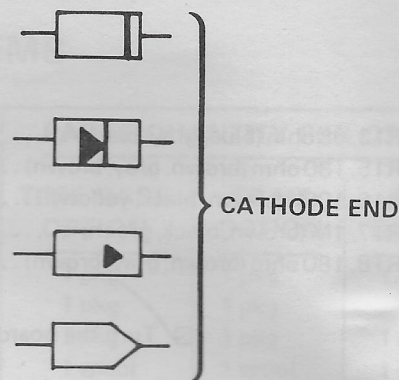


Figure 3. 60 HZ OPTION Resistor Installation Diagram

The parts you will mount next are diodes. THESE PARTS MUST BE INSTALLED WITH THE BANDED END (CATHODE) POSITIONED AS INSTRUCTED. The cathode end may be identified by any of markings commonly used on diodes as shown in the example. Refer to Figure 4, 5 or 6 for Diode and Capacitor installation location.



Mount the following diodes:

CR1, *CR2, *CR3, 1N914 Silicon diodes

CR4, 6.2V Zener diode

NOTE: Use pliers to bend leads.

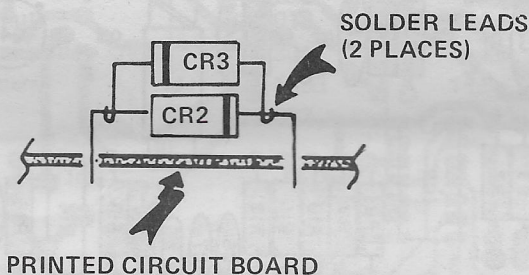
CR5, 1N914 Silicon diode.

TIME BASE OPTION

60 HZ OPTION



*For the 60 HZ OPTION, CR2 and CR3 are mounted back-to-back as shown in the following illustration. They are mounted in the CR2 position.



Mount the following capacitors:

C1 will not be mounted yet
(for ease of construction)

C2, 0.01 μ F, Disc

C3, 0.005 μ F, Disc

C4, 0.1 μ F, Disc

C5, 0.1 μ F, Disc

*C6, 47pF, Disc

*C7, 47pF, Disc

C8, 5pF, Disc

C9, 0.47 μ F, Tubular 250V

**C10, 0.005 μ F, Disc

TIME BASE OPTION

60 HZ OPTION

BCD OPTION



*Identifies parts directly associated with crystal Y1.

**Mount in the CR3 position (Detail "B" on figure 5). This properly locates C10 in the circuit.

☒ Is the tip of your soldering iron clean and freshly coated with solder. It will help to insure good solder connections.

☒ Turn the board over and solder. Trim off excess lead length.

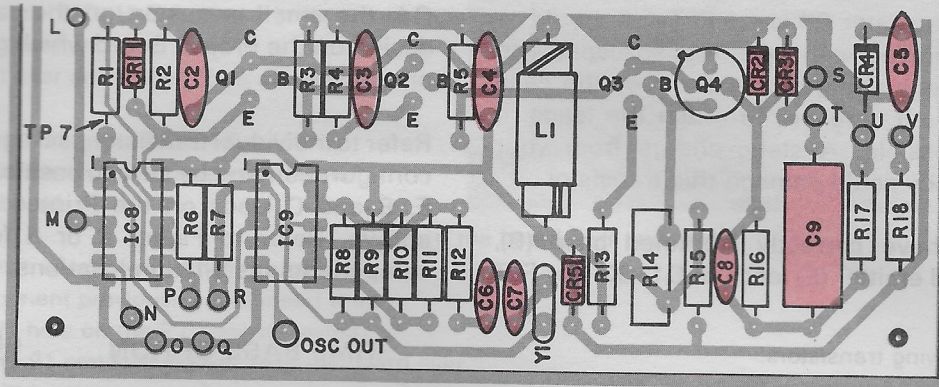


Figure 4. TIME BASE OPTION Diode and Capacitor Installation Diagram

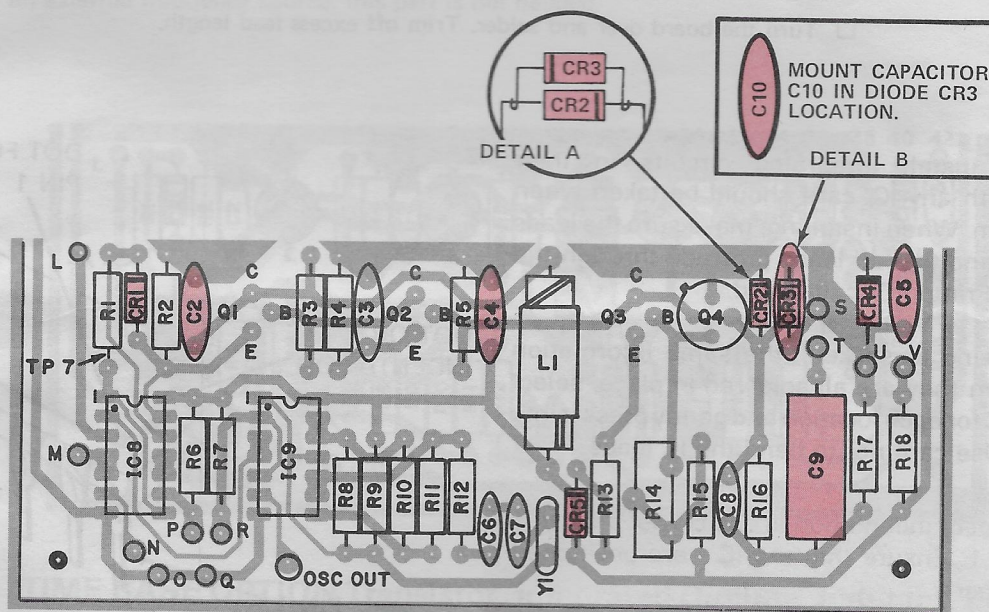


Figure 5. 60 HZ OPTION Diode and Capacitor Installation Diagram

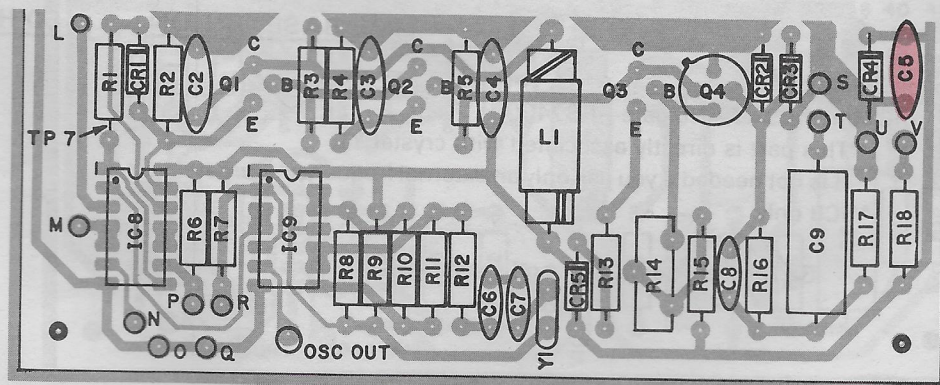


Figure 6. BCD OPTION Capacitor Installation Diagram

CAUTION: Transistor Q4 is a J-FET and should be handled with care. It is susceptible to static charges. Handle it by the case using care not to touch the leads, if possible. A static charge from your body could damage this transistor.

Be sure you have correctly identified base (B), collector (C) and emitter (E) leads of Q1–Q3. For FET

Q4, the small extrusion on the case matches the design on the Project Board which gives correct lead orientation.

Refer to individual transistor packages for proper lead configuration and be sure to position the transistor's E, B and C leads on the Printed Circuit Board as shown. Refer to Figure 7 or 8 for the following components installation locations.

Mount the following transistors:

Q1 and Q2, RS2011
Q3, RS2021
Q4, RS2036

TIME BASE OPTION



60 HZ OPTION

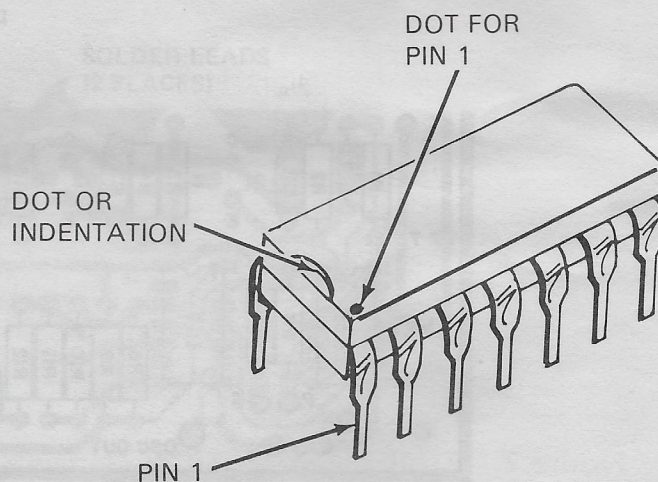


☐ Turn the board over and solder. Trim off excess lead length.

Next you'll install integrated circuits in their positions. With any IC, care should be taken when handling them. When installing, make sure the leads are straight and that all leads protrude through the holes in the Printed Circuit Board.

If you are using IC sockets, the same information applies. When they are all soldered in place, select the correct IC for each location and gently press it into the socket. Use care not to bend the IC leads.

NOTE: A dot or indentation at one corner indicates pin 1. Ensure that the IC's are positioned properly.



TIME BASE OPTION

60 HZ OPTION

Next mount the following IC's:

IC8 and *IC9—NAND gate—RS7400 *☒

**☐

*This part is directly associated with crystal Y1.

It is not needed if you use only an external frequency source.

**IC8 only

☒ Turn the board over and solder.

TIME BASE OPTION

60 HZ OPTION

Mount L1, 0.01mH (10 μ H) R.F. Choke in its proper location ☒

on the P.C. board.
Turn the board over and solder. Trim off excess lead length.

Mount R14, Potentiometer, P.C. 2.5K, 1/4W ☒

Mount *Y1, 10MHz crystal in its proper location on the P.C. board. ☐

☒ Turn the board over and solder.

Use a short piece of lead wire (that you cut ☒
from a component previously), and insert it into
the OSC OUT hole on the P.C. board leaving
about 3/4" (1.91 cm) sticking up. Turn the board over
and solder. This wire may be used as a tap for
a second clock signal if two are required, but
it is of opposite phase with the output 10 MHz signal.

*If you use an external frequency source, this part is not needed.

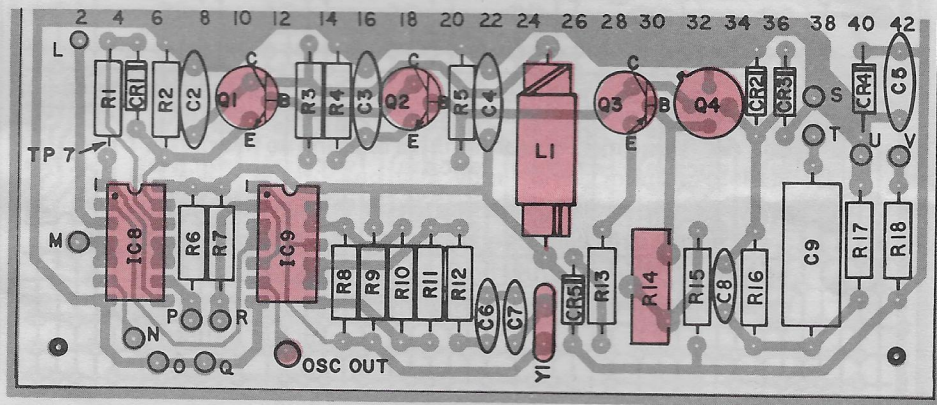


Figure 7. TIME BASE OPTION Transistor, Integrated Circuits, Inductor, Potentiometer and OSC OUT Test Point Installation Diagram

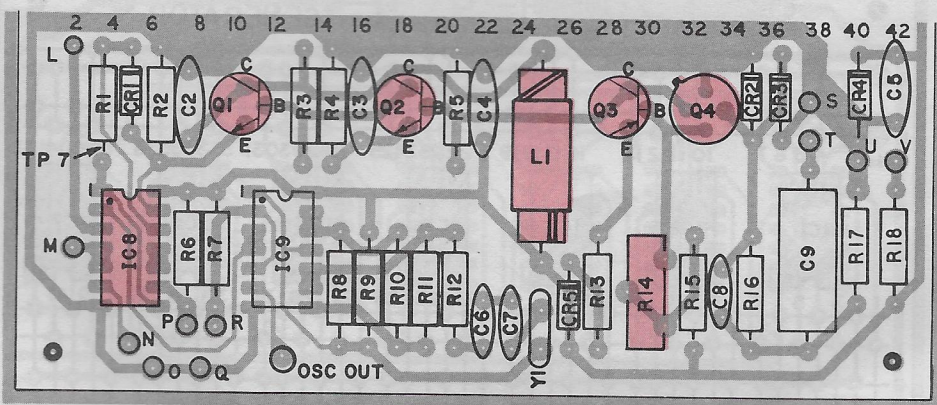


Figure 8. 60 HZ OPTION Transistor, Integrated Circuit, Inductor and Potentiometer Installation Diagram

Refer to Figure 9 or 10 for the following component installation locations.

	TIME BASE OPTION	60 HZ OPTION	BCD OPTION
IC1, Divide-By-Twelve Counter — RS7492	☒	☐	☐
IC1 through IC7, Decade Counter — RS7490	☒	☒	☐

*The 60 HZ OPTION Uses only IC2 and 3 of this group.

Mount C1 — 10 μ F, 35V, Axial, Electrolytic

Be sure to mount with + and/or - end leads going into the + and - marked holes.

☒ Turn the board over and solder.

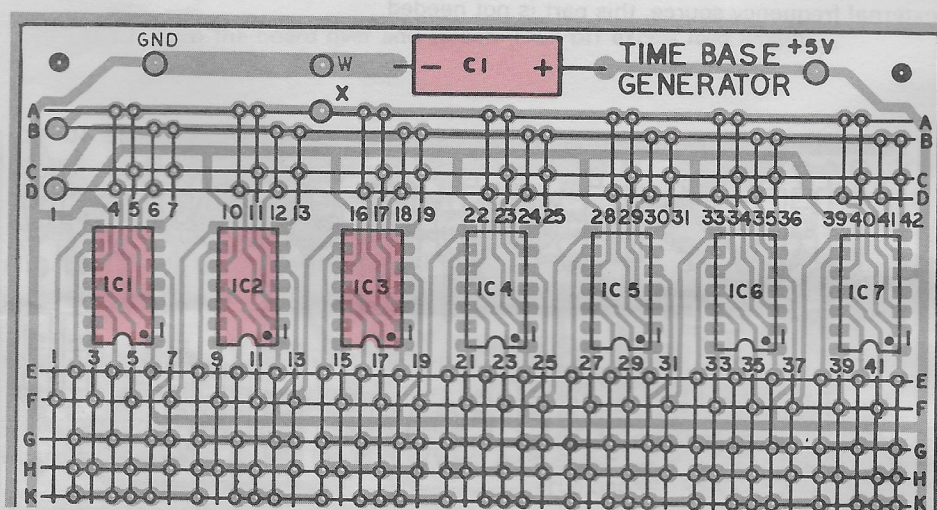


Figure 9. TIME BASE OPTION and BCD OPTION IC and Capacitor Installation Diagram

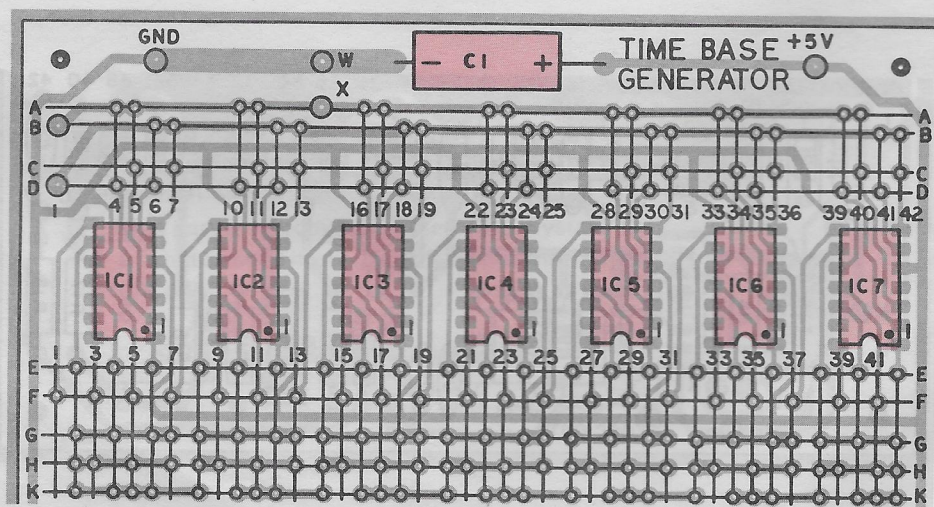


Figure 10. 60 HZ OPTION IC and Capacitor Installation Diagram

Okay! Let's take a short break from the action. Get up and walk around, have a cup of coffee or something. After relaxing a bit, go back and check your work. You may save some headaches downstream by assuring that all of the parts are mounted properly on the Project Board and that your solder joints are clean and shiny. After the break and a check of your work, get back into action by proceeding to the instructions on the following pages. And don't forget to keep your iron clean and brightly coated with a fresh layer of melted solder.

JUMPER WIRE INSTALLATION INSTRUCTIONS

You are now ready to install the jumper wires in the various grid locations. Refer to Figure 11, 12 or 13 for jumper wire installation location. Strip the insulation from a length of solid hookup wire (RS Cat. No. 278-1295) and use the stripped wire for your jumpers. Use jumper wires cut to a length equal to

the point-to-point wire location on the Project Board plus enough to protrude through the board for soldering.

All point-to-point jumper wiring information for a particular option is located on the same page.

After you have installed 8 to 10 jumper wires turn the board over and solder. Cut off excess lead length.

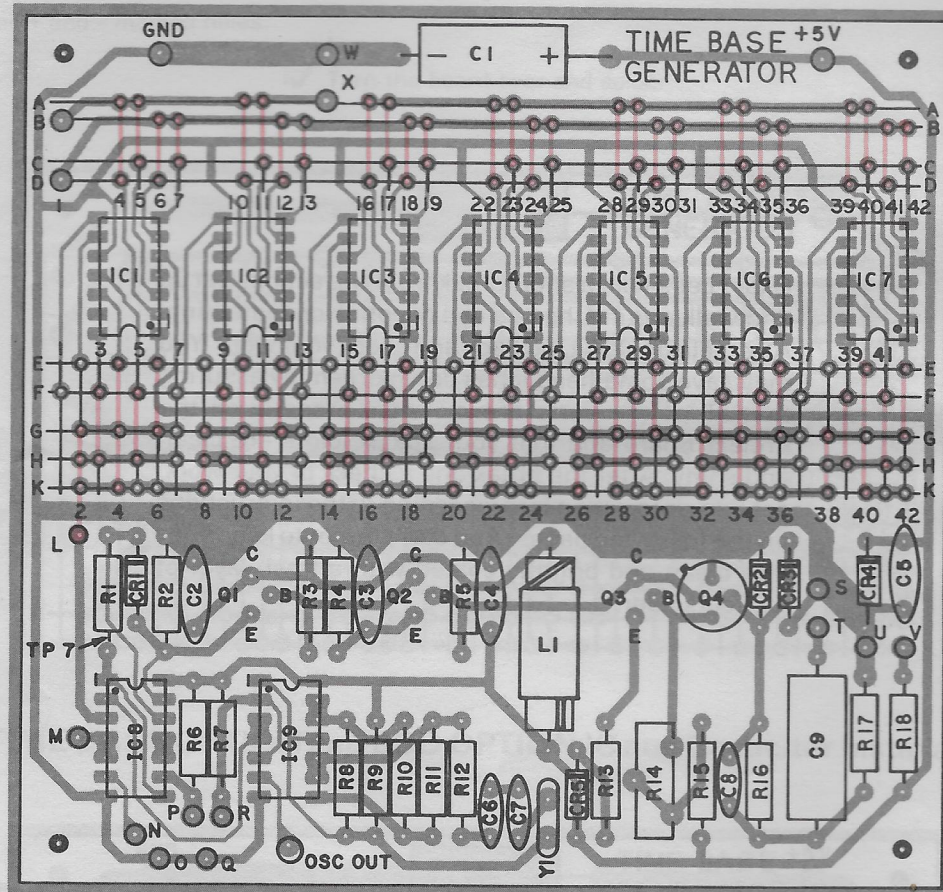


Figure 11. TIME BASE OPTION Jumper Wiring

TIME BASE OPTION

- | | | | | |
|--|--|--|--|--|
| ☒ A4 to D4 | ☒ A23 to C23 | ☒ B41 to D41 | ☒ F15 to H15 | ☒ E30 to G30 |
| ☒ A5 to C5 | ☒ B24 to D24 | ☒ B42 to C42 | ☒ E16 to K16 | ☒ G32 to K32 |
| ☒ B6 to D6 | ☒ B25 to C25 | ☒ G2 to L | ☒ F17 to H17 | ☒ F33 to H33 |
| ☒ B7 to C7 | ☒ A28 to D28 | ☒ F3 to H3 | ☒ E18 to G18 | ☒ E34 to K34 |
| ☒ A10 to D10 | ☒ A29 to C29 | ☒ E4 to K4 | ☒ G20 to K20 | ☒ F35 to H35 |
| ☒ A11 to C11 | ☒ B30 to D30 | ☒ F5 to H5 | ☒ F21 to H21 | ☒ E36 to G36 |
| ☒ B12 to D12 | ☒ B31 to C31 | ☒ E6 to G6 | ☒ E22 to K22 | ☒ G38 to K38 |
| ☒ B13 to C13 | ☒ A33 to D33 | ☒ G8 to K8 | ☒ F23 to H23 | ☒ F39 to H39 |
| ☒ A16 to D16 | ☒ A34 to C34 | ☒ F9 to H9 | ☒ E24 to G24 | ☒ E40 to K40 |
| ☒ A17 to C17 | ☒ B35 to D35 | ☒ E10 to K10 | ☒ G26 to K26 | ☒ F41 to H41 |
| ☒ B18 to D18 | ☒ B36 to C36 | ☒ F11 to H11 | ☒ F27 to H27 | ☒ E42 to G42 |
| ☒ B19 to C19 | ☒ A39 to D39 | ☒ E12 to G12 | ☒ E28 to K28 | |
| ☒ A22 to D22 | ☒ A40 to C40 | ☒ G14 to K14 | ☒ F29 to H29 | |

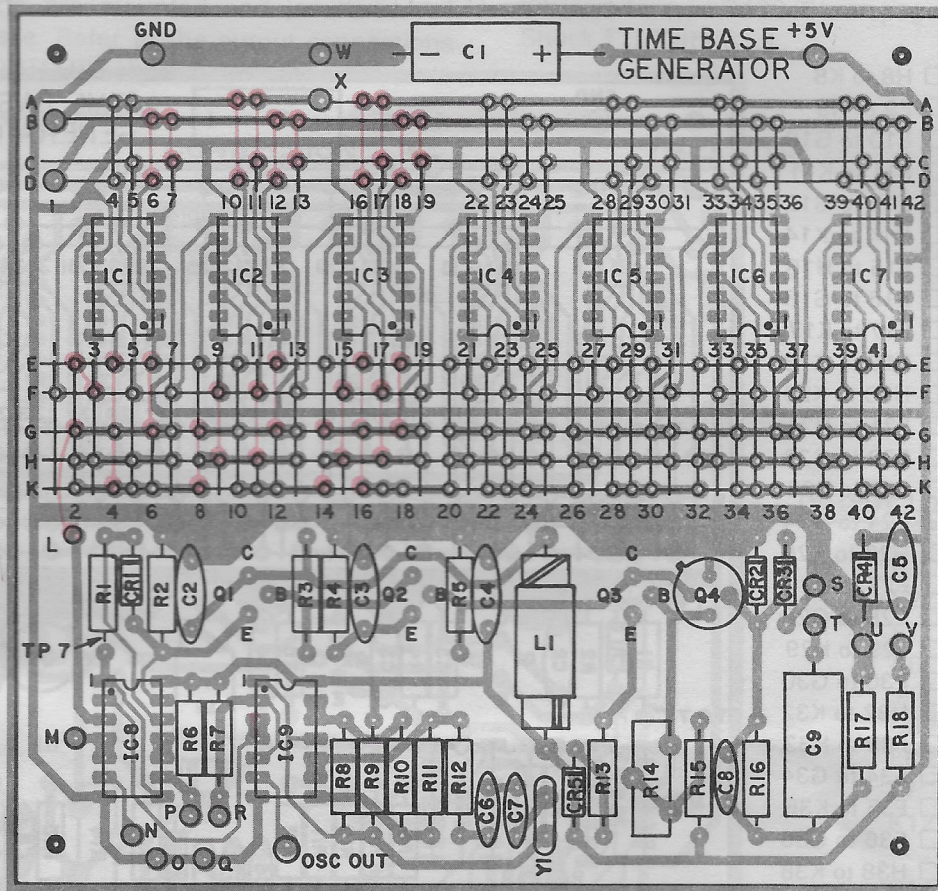


Figure 12. 60 HZ OPTION Jumper Wiring

60 HZ OPTION

- | | | |
|-------------------------------------|-------------------------------------|---------------------------------------|
| ☐ B6 to D6 | ☐ B19 to C19 | ☐ E12 to G12 |
| ☐ B7 to C7 | ☐ G2 to L | ☐ G14 to K14 |
| ☐ A10 to D10 | ☐ E2 to F3 | ☐ F15 to H15 |
| ☐ A11 to C11 | ☐ E4 to K4 | ☐ E16 to K16 |
| ☐ B12 to D12 | ☐ E6 to G6 | ☐ F17 to H17 |
| ☐ B13 to C13 | ☐ G8 to K8 | ☐ E18 to G18 |
| ☐ A16 to D16 | ☐ F9 to H9 | ☐ IC9 location |
| ☐ A17 to C17 | ☐ E10 to K10 | pin hole 2 to |
| ☐ B18 to D18 | ☐ F11 to H11 | pin hole 3 |

When you have 8 to 10 jumper wires installed in one sequence, turn the board over and solder jumper wires to the foil. Cut off excess lead length.

BCD OPTION

After installing 8 to 10 jumpers, turn the board over and solder leads to the foil.
Cut off excess lead length.

- | | |
|-------------------------------------|---------------------------------------|
| ☐ A4 to D4 | ☐ H8 to K8 |
| ☐ A5 to C5 | ☐ F9 to H9 |
| ☐ B6 to D6 | ☐ E10 to G10 |
| ☐ B7 to C7 | ☐ F11 to K11 |
| ☐ A10 to D10 | ☐ E12 to G12 |
| ☐ A11 to C11 | ☐ H14 to K14 |
| ☐ B12 to D12 | ☐ F15 to H15 |
| ☐ B13 to C13 | ☐ E16 to G16 |
| ☐ A16 to D16 | ☐ F17 to K17 |
| ☐ A17 to C17 | ☐ E18 to G18 |
| ☐ B18 to D18 | ☐ H20 to K20 |
| ☐ B19 to C19 | ☐ F21 to H21 |
| ☐ A22 to D22 | ☐ E22 to G22 |
| ☐ A23 to C23 | ☐ F23 to K23 |
| ☐ B24 to D24 | ☐ E24 to G24 |
| ☐ B25 to C25 | ☐ H26 to K26 |
| ☐ A28 to D28 | ☐ F27 to H27 |
| ☐ A29 to C29 | ☐ E28 to G28 |
| ☐ B30 to D30 | ☐ F29 to K29 |
| ☐ B31 to C31 | ☐ E30 to G30 |
| ☐ A33 to D33 | ☐ H32 to K32 |
| ☐ A34 to C34 | ☐ F33 to H33 |
| ☐ B35 to D35 | ☐ E34 to G34 |
| ☐ B36 to C36 | ☐ F35 to K35 |
| ☐ A39 to D39 | ☐ E36 to G36 |
| ☐ A40 to C40 | ☐ H38 to K38 |
| ☐ B41 to D41 | ☐ F39 to H39 |
| ☐ B42 to C42 | ☐ E40 to G40 |
| ☐ H2 to L | ☐ F41 to K41 |
| ☐ F3 to H3 | ☐ E42 to G42 |
| ☐ E4 to G4 | ☐ IC8 location |
| ☐ F5 to K5 | pin hole 3 to |
| ☐ E6 to G6 | pin hole 6 |

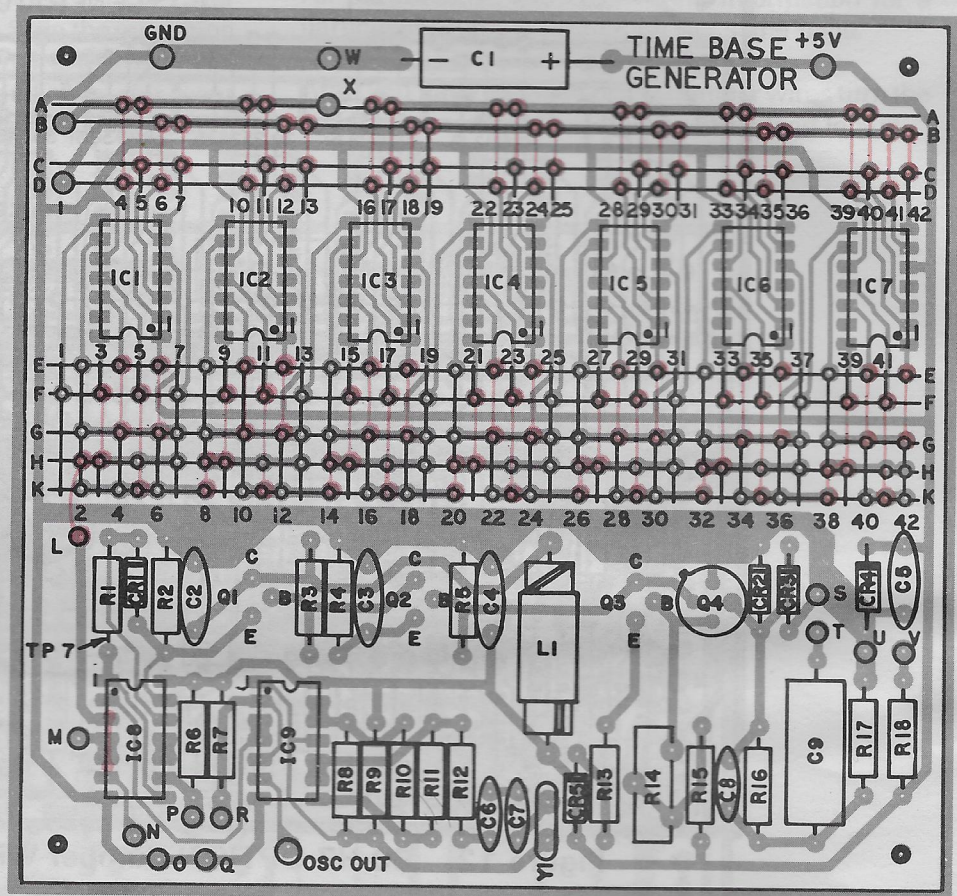


Figure 13. BCD OPTION Jumper Wiring

CHECK YOUR WORK

This completes the component assembly on the Printed Circuit Board.

We suggest that you go over your work to be sure that all of the solder joints are clean and shiny and that none of the foil has pulled up from the board due to excessive heat. Double check to be sure all component connections are soldered to the foil, and that no solder has flowed across/between foil paths.

That last sequence was quite an effort! Well just to make sure you got all the jumpers in correctly, lay your Board next to figure 11, 12 or 13 and visually compare the art against your Board. **Be sure EACH jumper is in place — and between the correct holes.** Everything look OK? Then proceed.

BCD OPTION INFORMATION

If you have wired the BCD option, it is completed when the parts are mounted and jumper wires soldered in place. Refer to the output connections and the BCD OUTPUTS chart, below, for a complete

list of the decade counters, each of their BIT outputs and each BIT location on the Project Board. For a detailed presentation of the BIT outputs, see the logic diagram for type 7490 IC's on page 2-33 of the Radio Shack TTL Data Book.

CONNECTION

Signal Input
Signal GND
R₀ (1 and 2)
R₉ (1 and 2)

LOCATION

N
O
B1
D1

BCD OUTPUTS

POWERS OF TEN DECADE

IC NO.

BIT

OUTPUT LOCATION

10⁶

1

1
2
4
8

G2
E2
F1
K6

10⁵

2

1
2
4
8

G8
E8
F7
K12

10⁴

3

1
2
4
8

G14
E14
F13
K18

10³

4

1
2
4
8

G20
E20
F19
K24

10²

5

1
2
4
8

G26
E26
F25
K30

10¹

6

1
2
4
8

G32
E32
F31
K36

10⁰

7

1
2
4
8

G38
E38
F37
K42

CABINET PREPARATION

Basic hand tools required to prepare the cabinet for components mounting include a common screwdriver, Phillips screwdriver, center punch, power drill and a nibbling tool.

Front and rear panel drill templates, Figures 27 and 28 (located on separate sheets) are used to locate the holes for mounting parts to the cabinet. The bottom drill template Figure 29 (located on a separate sheet) is used to locate holes for mounting the printed circuit board.

NOTE: For the 60 HZ OPTION S1 is not required — so don't drill a hole for it.

- ☐ The recommended cabinet for this Project Board is the Radio Shack Catalog number 270-253. After removing the lower, or base portion of the case, fit the

front panel drill template to the case. Tape in place. Follow the directions on the drill template.

- ☐ Then, fit the rear panel drill template to the case. Tape in place. Follow the directions on the drill template.
- ☐ Now mount the front label to the front panel of the cabinet. This is easily done by stripping away the protective label backing. Place one edge of the label on one edge of the front panel, and with a slight rolling action, press and smooth this label against the panel. Follow the same procedure for mounting the rear panel label. When the front and rear panel labels are in place, use a sharp instrument like a knife to cut out the designated holes.
- ☐ With the case upside-down, remove the rubber feet from the cabinet and fit the Bottom Drill Template on the case. Tape in place. Follow the directions on the Bottom Drill Template.

MOUNTING OF COMPONENTS TO CABINET

Refer to Figure 14 and 15 for cabinet mounted components locations.

Mount the following components to the front panel:

S1, SPDT Toggle Switch

S2, Rotary Switch **NOTE:** Cut the shaft to length. The length should be long enough to enter and seat in the knob but not so short that the knob will touch the front panel surface. Shaft length from the threaded end to the end which seats in the knob should be approximately 5/8" (1.59 cm). Ensure that the index tab extends through the front panel index hole.

TIME BASE OPTION

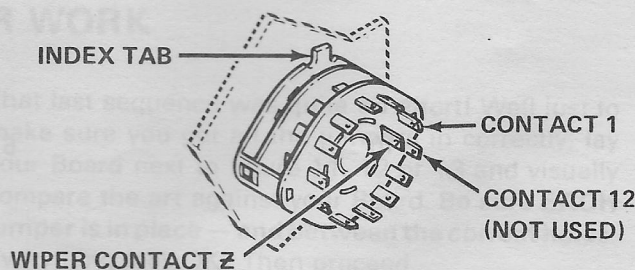
60 HZ OPTION

- ☐
- ☐

☐

Refer to the detail illustration, at right, to help locate contact Z (wiper contact) and contact 1 of S2.

Rotate the shaft and observe when the wafer rotor contact is touching contact 1. Now mount the knob so that the indicator on the knob is pointing to designation on the front panel label. Then tighten the knob set-screw to secure the knob to the shaft.



DETAIL OF SWITCH S2

TIME BASE OPTION

60 HZ OPTION

DS1, Light Emitting Diode NOTE: LED Cathode lead identification: ☐ ☐

Due to the reluctance of manufacturers to standardize the method of cathode and anode lead identification, it is advisable for you to test them. This can be done in the following manner:

With two 1-1/2 volt batteries connected in series, forming a 3 volt power supply, connect a resistor — any value from 100 ohms to 470 ohms — to the positive side of the batteries.

Test the LED's by connecting one lead of the LED to the negative side of the batteries and the other lead to the resistor which is connected to the positive side.

If the LED lights, the lead connected to the negative side is the cathode. If it does not light, reverse the LED leads to identify the cathode.

J1, Red Nylon Binding Post (EXTERNAL INPUT) ☐ ☐

J2, Black Nylon Binding Post (EXTERNAL INPUT) ☐ ☐

J3, Red Nylon Binding Post (OUTPUT) ☐ ☐

J4, Black Nylon Binding Post (OUTPUT) ☐ ☐

Mount the terminal board (TB1) on the rear panel, securing

it with two 4-40 X 1/2" (1.27cm) screws, #4 flat washers and 4-40 nuts.

NOTE: Use the flat washer against the terminal board. That is, put the screw through the washer then through the terminal board and secure it to the back panel with the nut.

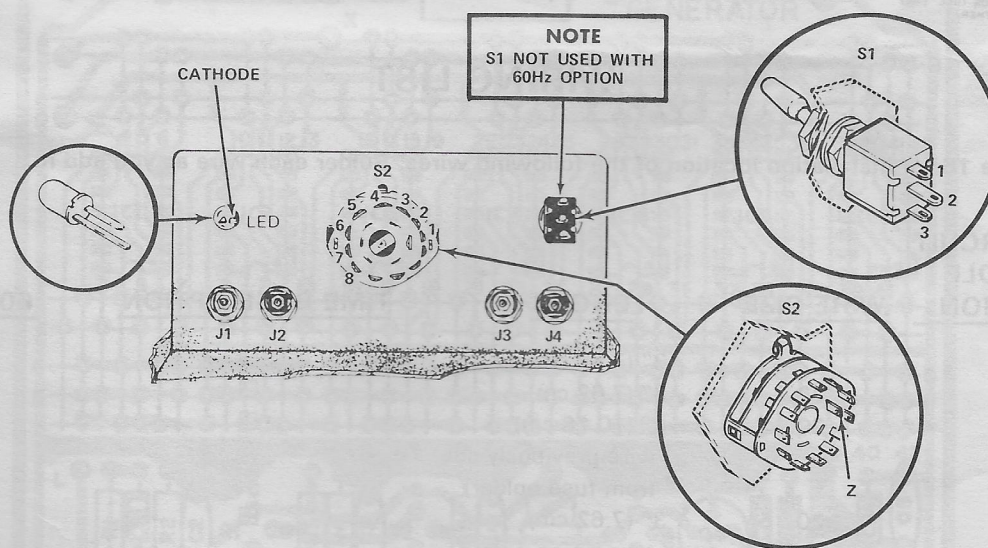


Figure 14. Installation Diagram, Inside View of Front Panel as Viewed From the Rear

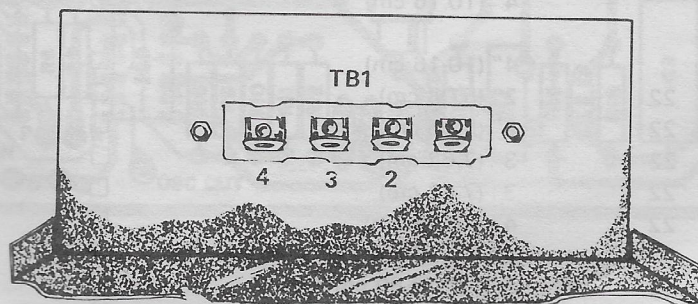


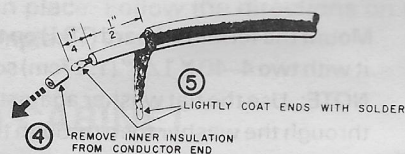
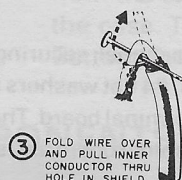
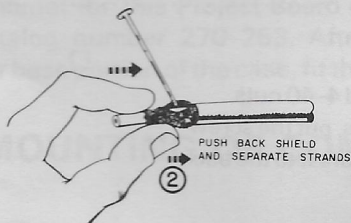
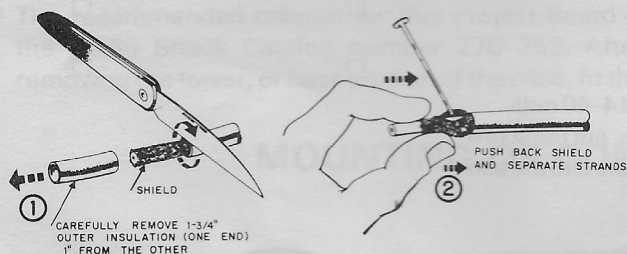
Figure 15. Installation Diagram, Inside View of Rear Panel as Viewed From the Front

CUTTING AND ADDING WIRE TO PRINTED CIRCUIT BOARD

Refer to the WIRING LIST for wire size, wire length, Printed Circuit Board mounting location and sequence of installation.

Wires need to be long enough to allow for installation of the spacers which hold the soldered side of the Printed Circuit Board away from the base of the cabinet and mount the Printed Circuit Board to the cabinet.

- ☐ Cut 4" (10.16 cm) of wire from the longest lead of the Fuse Holder. You will use this 4" (10.16 cm) wire later to connect the GND contact of the Printed Circuit Board to the GND terminal on the rear panel.



⑤ LIGHTLY COAT ENDS WITH SOLDER

③ FOLD WIRE OVER AND PULL INNER CONDUCTOR THRU HOLE IN SHIELD

WIRING LIST

Refer to Figure 16 for installation location of the following wires. Solder each wire as you add it.

PRINTED CIRCUIT BOARD HOLE DESIGNATION

DESIGNATION	WIRE SIZE	LENGTH	TIME BASE OPTION	60 HZ OPTION
D1	22	3" (7.62 cm)	☐	☐
B1	22	3" (7.62 cm)	☐	☐
GND	20	4" (10.16 cm) wire previously cut from fuse holder)	☐	☐
+5V	20	3" (7.62 cm) (remaining wire with fuse holder)	☐	☐
T (Inner conductor) shielded cable		4" (10.16 cm)	☐	☐
S (braided conductor)		4" (10.16 cm)	☐	☐
N	22	2" (5.08 cm)	☐	☐
O	22	2" (5.08 cm)	☐	☐
V	22	3" (7.62 cm)	☐	☐
U	22	3" (7.62 cm)	☐	☐
K42	22	4" (10.16 cm)	☐	☐
K36	22	4" (10.16 cm)	☐	☐
M	22	3 1/2" (8.89 cm)	☐	☐
K30	22	4" (10.16 cm)	☐	☐
K24	22	4" (10.16 cm)	☐	☐

PRINTED CIRCUIT
BOARD HOLE
DESIGNATION

WIRE SIZE

LENGTH

TIME BASE OPTION

60 HZ OPTION

K18	22	4" (10.16 cm)	☐	☐
K12	22	4" (10.16 cm)	☐	☐
K6	22	4" (10.16 cm)	☐	☐
G7	22	4" (10.16 cm)	☐	☐
P	22	3" (7.62 cm)	☐	
Q	22	3" (7.62 cm)	☐	
R	22	3" (7.62 cm)	☐	

This completes the soldering of wires to the printed circuit board. Check to see that all of your solder joints are clean and shiny and that none of the foil has pulled up from the Printed Circuit Board due to excessive heat.

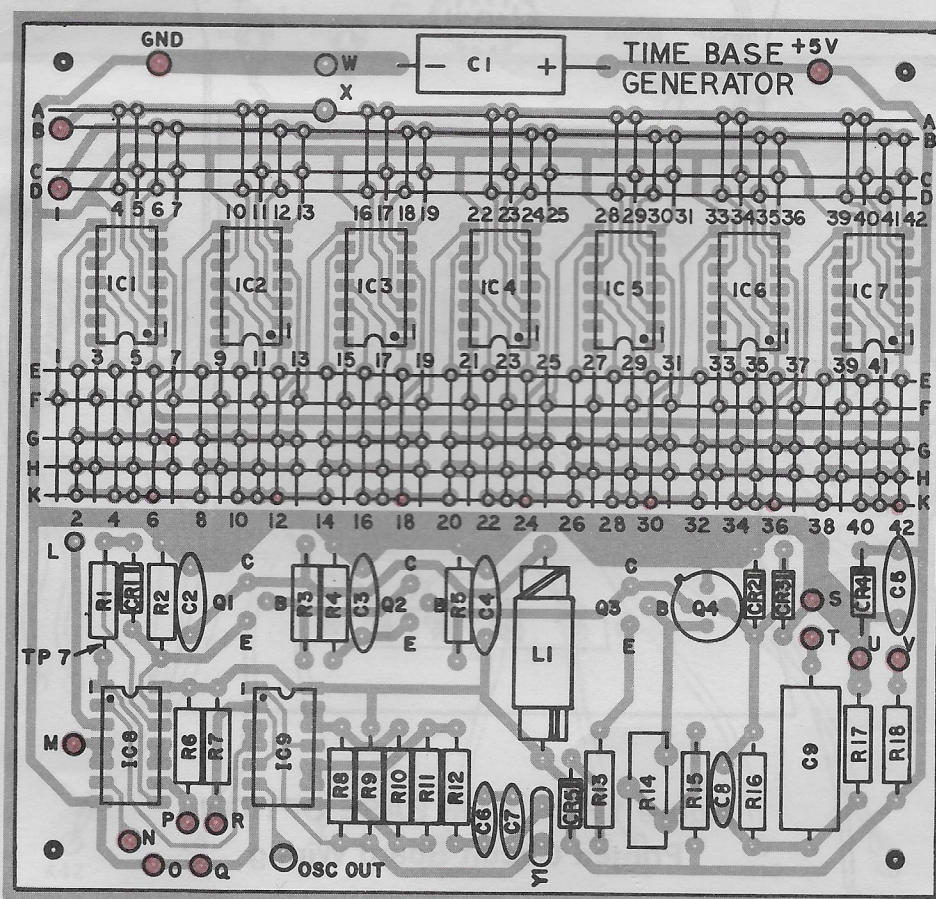
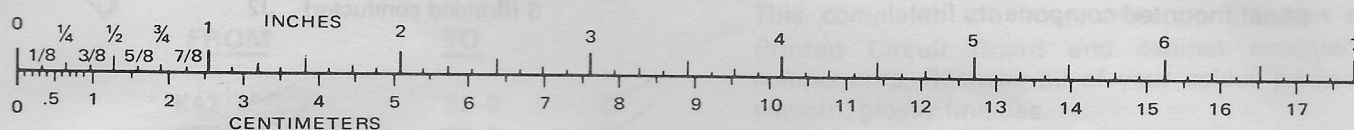


Figure 16. Installation of Hookup Wires

TIME BASE OPTION ONLY

HOOK UP SEQUENCE

- ☐ Place the Printed Circuit Board in the cabinet. DO NOT MOUNT YET. You should now be ready to connect the wires from the Printed Circuit Board to the cabinet mounted components. **The following hook up procedures apply only to the TIME BASE OPTION.** Use the "from" — "to" information provided on the HOOK UP SEQUENCE chart and Figure 17.1 and 17.2 as guides to correct point-to-point connection. For the first series of connections, refer to Figure 17.1 and the following part of the HOOK UP SEQUENCE chart. Connect and solder the applicable wires to the cabinet rear panel mounted components first.

FROM

D1
B1
GND
+5V

TO

TB1-4
TB1-3
TB1-2
TB1-1

☒
☒
☒
☒

Connect and solder the shielded cable wires as follows:

T (Inner conductor) J1
shielded cable
S (Braided conductor) J2

☒
☒

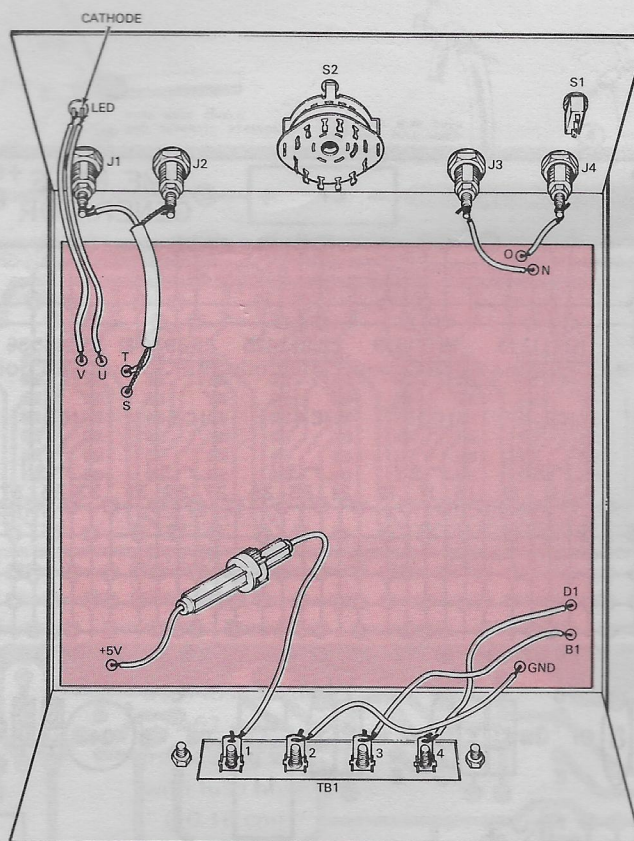


Figure 17.1 TIME BASE OPTION
Printed Circuit Board Wiring

Next connect and solder the wires to jacks J3 and J4 as follows:

FROM	TO
N	J3 ☒
O	J4 ☒
U	LED Cathode ☒
V	LED Anode ☒

The next series of wire connections and soldering should be accomplished using Figure 17.2 and the following portion of the HOOK UP SEQUENCE chart.

HOOK UP SEQUENCE

FROM	TO
K42	S2-8 ☒
K36	S2-7 ☒
M	S2-Z ☒
G7	S2-1 ☒
P	S1-3 ☒
Q	S1-2 ☒
R	S1-1 ☒

The final series of connections and soldering to cabinet mounted components is accomplished by using that data in the following portion of the HOOK UP SEQUENCE chart and referring to Figure 17.2.

HOOK UP SEQUENCE

FROM	TO
K30	S2-6 ☒
K24	S2-5 ☒
K18	S2-4 ☒
K12	S2-3 ☐
K6	S2-2 ☐

This completes the interconnection between the Printed Circuit Board and cabinet mounted components. Recheck all of your solder joints for smooth, glossy finishes.

Compare your wire connections to those shown in Figure 17.1 and 17.2 to ensure that you made all of your connections to the correct points.

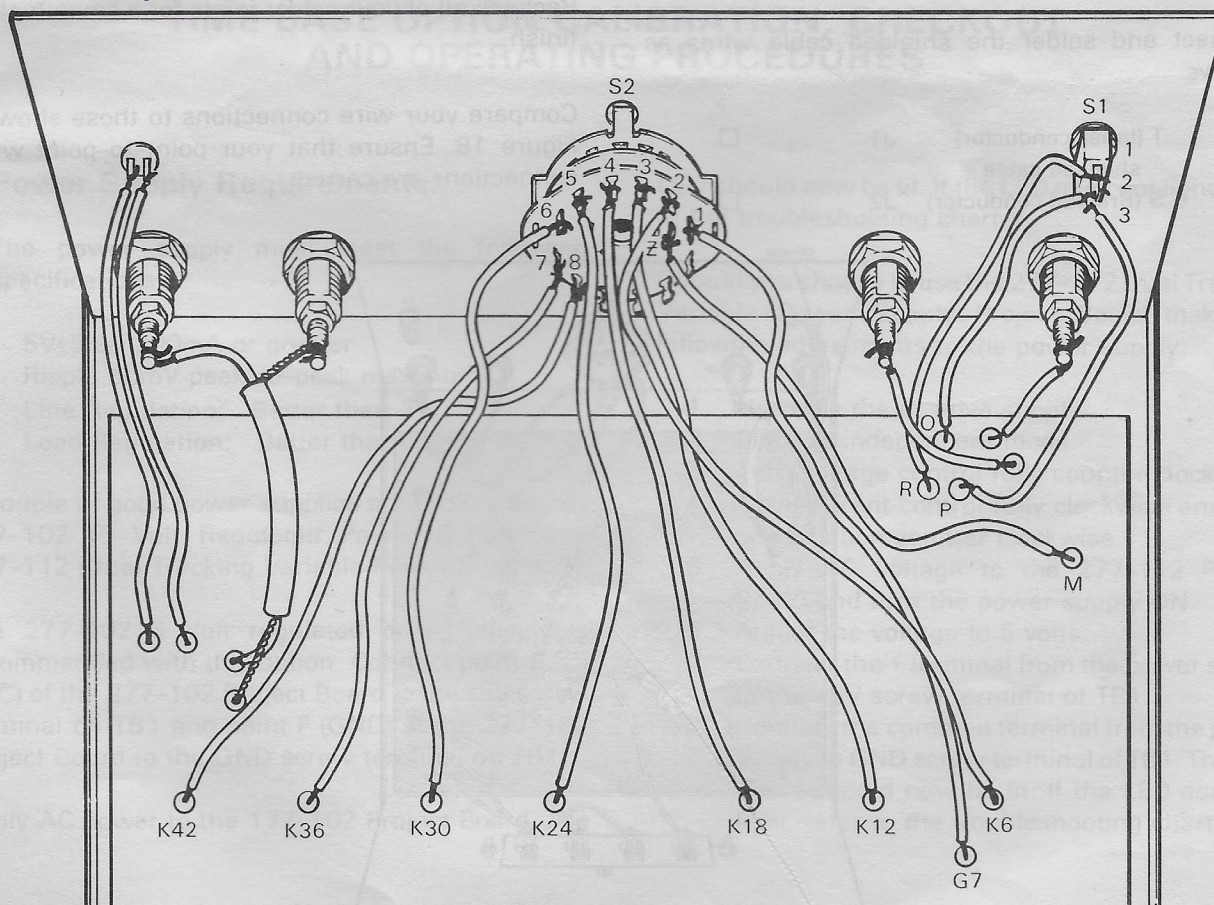


Figure 17.2 TIME BASE OPTION
Printed Circuit Board Wiring

60 HZ OPTION ONLY

The following hook up procedures apply only to the 60 HZ OPTION.

- ☐ Place the Printed Circuit Board in the cabinet. DO NOT MOUNT YET. You should now be ready to connect the wires from the Printed Circuit Board to the cabinet mounted components. Use the "from" — "to" information provided on the HOOK UP SEQUENCE chart and Figure 18, 60 HZ OPTION Printed Circuit Board Wiring as guides to correct point-to-point connection. Connect and solder the applicable wires to the cabinet rear panel mounted components first.

HOOK UP SEQUENCE

FROM	TO	
D1	TB1-4	☐
B1	TB1-3	☐
GND	TB1-2	☐
+5V	TB1-1	☐

Connect and solder the shielded cable wires as follows:

T (Inner conductor)	J1	☐
shielded cable		
S (Braided conductor)	J2	☐

Next connect and solder the wires to jacks J3 and J4 as follows:

FROM	TO	
N	J3	☐
O	J4	☐

Connect and solder the wires to LED cathode and anode as follows:

U	LED Cathode	☐
V	LED Anode	☐

Next connect and solder wires to switch S2 as follows:

K18	S2-8	☐
K12	S2-7	☐
K6	S2-6	☐
M	S2-Z	☐

This completes the interconnection between the Printed Circuit Board and cabinet mounted components.

Recheck all of your solder joints for a smooth glossy finish.

Compare your wire connections to those shown in Figure 18. Ensure that your point-to-point wiring connections are correct.

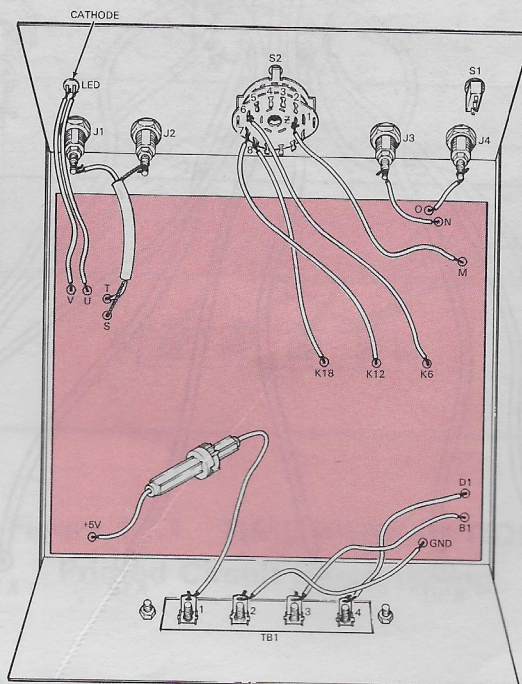


Figure 18. 60 HZ OPTION Printed Circuit Board Wiring

60 HZ OPTION FRONT PANEL MODIFICATION

To change the front panel rotary switch (S2) position designations to show the desired output signal selection, prepare three labels using a label maker (RS CAT. NO 64-526 or equivalent) or white tape.

- ☐ Print "10 Hz" on one label and cover the $\frac{100}{100K}$ designation on the front panel.
- ☐ Print "1 Hz" on one label and cover the $\frac{10}{10K}$ designation on the front panel.
- ☐ Print ".01 Hz" on one label and cover the $\frac{1}{10M}$ designation on the front panel.

FINAL ASSEMBLY INSTRUCTIONS, TIME BASE OPTION AND 60 HZ OPTION

- ☐ Mount the P. C. board in the cabinet using four 4-40 x 3/4" (1.91 cm) screws, four 1/2" (1.27 cm) spacers four flat washers and four 4-40 nuts.
- ☐ **CONSTRUCTION NOTE:** Turn your unit upside down. Insert the four 4-40 screws through the mounting holes. Using four short pieces of tape, cover the screw heads. This will allow you to hold your P. C. board up away from the chassis while placing the spacers over the screws. Place the P. C. board over the mounting screws against the spacers. Secure in position using the flat washers and four 4-40 nuts.
- ☐ Remount rubber feet on cabinet.
- ☐ Install a 1/2-Amp Fuse in the Fuse Holder.

TIME BASE OPTION CALIBRATION, CHECKOUT AND OPERATING PROCEDURES

Power Supply Requirements.

The power supply must meet the following specifications:

5V±5%@300mA or greater
Ripple 50mV peak-to-peak maximum
Line Regulation: Better than 2%
Load Regulation: Better than 2%

A couple of good power supplies are Project Boards 277-102 (5 Volt Regulated Power Supply) and 277-112 (Dual Tracking Variable Power Supply).

The 277-102 5 Volt regulated power supply is recommended with this option. Connect point E (+5 VDC) of the 277-102 Project Board to the +5V screw terminal on TB1 and point F (GND) of the 277-102 Project Board to the GND screw terminal on TB1.

Apply AC power to the 177-102 Project Board. The

LED should now be lit. If the LED does not light, refer to the troubleshooting chart.

Should you choose to use the 277-112 Dual Tracking Variable Power Supply Project Board make the following adjustments to the power supply:

1. Use only the positive supply.
2. Place in independent mode.
3. Turn voltage control fully counter clockwise.
4. Turn current control fully clockwise and then one position counter clockwise.
5. Apply AC voltage to the 277-112 Project Board and turn the power supply ON.
6. Adjust the voltage to 5 volts.
7. Connect the + terminal from the power supply to the +5V screw terminal of TB1.
8. Connect the common terminal from the power supply to GND screw terminal of TB1. The LED (DS1) should now be lit. If the LED does not light, refer to the troubleshooting chart.

— CALIBRATION —

Test Equipment Required.

1. Signal Generator with a continuously variable output from 100 mV to 1 volt RMS. (10 Hz to 10 MHz frequency range preferred.)
2. Oscilloscope with DC-10 MHz vertical band width.

The following steps determine the accuracy and dependability of your Time Base Generator using an external signal source.

- ☐ Connect signal generator to EXTERNAL INPUT and select EXT on switch S1.
- ☐ Select the highest frequency (10 MHz maximum) on the Signal Generator with approximately 1 V RMS.
- ☐ Connect the oscilloscope input to TP7 (Pin 8, IC 8) with the vertical input set to 1V/DIV if a direct probe is used or 0.1V/DIV if a 10:1 divider probe is used. Adjust R14 until a square wave of the same frequency as the input frequency appears on the oscilloscope.

- ☐ Reduce the output of the signal generator until the square wave disappears and readjust R14 until the square wave reappears.

- ☐ Continue alternately decreasing the signal generator output and adjusting R14 until the lowest signal level yields a stable square wave of the same frequency as the input.

- ☐ Lower the frequency of the signal generator to 10 Hz and repeat the previous step if a stable square wave is not present.

- ☐ Switch the signal generator frequency between 10 Hz and the highest frequency (10 MHz maximum).

A square wave should track both frequencies if R14 is adjusted correctly. If a square wave does not track both frequencies:

- ☐ Increase the output level of the signal generator and adjust R14 until the square wave tracks the 10 Hz and the highest frequency (10 MHz maximum).

— CHECKOUT AND OPERATING PROCEDURES —

- ☐ 1. Connect a jumper wire from GND screw terminal to R₀ screw terminal and R₉ screw terminal on TB1. This places the I.C.'s in the divider chain into their count mode. The R₀ and R₉ lines can be connected to external circuitry later if you want external control of them. (Refer to page 4 in the divider chain portion of the Theory of Operation.)
- ☐ 2. Connect oscilloscope input to output connections (J3 and J4) with the vertical input set to 1V/DIV if direct probe is used or 0.1V/DIV if a 10:1 divider probe is used.
- ☐ 3. Connect Signal Generator to external input and select EXT on S1.
- ☐ 4. Select highest frequency (10 MHz maximum) on Signal Generator with approximately 1 V RMS.
- ☐ 5. Select $\frac{10M}{1}$ on S2. A square wave of the same frequency as the input frequency should appear on the oscilloscope.

- ☐ 6. Select $\frac{1M}{10}$ on S2. A square wave which is 1/10th of the input frequency should appear on the oscilloscope.

- ☐ 7. Select $\frac{100K}{100}$ through $\frac{1}{10M}$. The frequency of the square wave output should be the same division of the input frequency as the division selected.

If any problems occur during above steps, recheck wiring of S1 and S2 and associated wiring to the Printed Circuit Board. If problems still exist, refer to troubleshooting chart.

The following steps ensure proper operation of the internal crystal oscillator.

- ☐ 1. Select INT on S1.
- ☐ 2. Select $\frac{10M}{1}$ on S2. A 10 MHz square wave should appear on the oscilloscope.

- ☐ 3. Select 10^1 through 10^0 . The frequency of the output square wave should correspond with the frequency selected on S2.

If any problems occur during above steps, recheck wiring of S1 and S2 and associated wiring to the Printed Circuit Board. If problems still exist, refer to the troubleshooting chart.

This concludes the construction, calibration and checkout of your TIME BASE OPTION.

Post Calibration. Disconnect the test equipment. Install cover.

60Hz OPTION CALIBRATION, CHECKOUT AND OPERATING PROCEDURES

Power Supply Requirements

The 277-102 5-Volt regulated power supply is recommended with this option. Connect point E (+5 VDC) of the 277-102 Project Board to the +5V screw terminal on TB1 and point F (GND) of the 277-102 Project Board to the GND screw terminal on TB1.

Now connect point G of the 277-102 Project Board to the red binding post (J1) of the external input of the Time Base Generator. Apply AC power to the 277-102 Project Board. The LED should now be lit. If the LED does not light, refer to the troubleshooting chart.

— CALIBRATION —

Test Equipment Required

A general purpose oscilloscope is required to calibrate your Time Base Generator.

Connect oscilloscope vertical input to TP7 with vertical input set to 1V/DIV if a direct probe is used or 0.1V/DIV if a 10:1 divider probe is used. Adjust R14 until a stable 60 Hz square wave appears on oscilloscope.

— CHECKOUT AND OPERATING PROCEDURES —

- ☐ 1. Connect a jumper wire from GND screw terminal to R₀ screw terminal and R₉ screw terminal on TB1. This places the I.C.'s in the divider chain into their count mode. The R₀ and R₉ lines can be connected to external circuitry later if you want external control of them. (Refer to page 4 in the divider chain portion of the Theory of Operation.)

- ☐ 2. Connect oscilloscope vertical input to output connections (J3 and J4) of the Time Base Generator with the vertical input set to 1V/DIV if a direct probe is used or 0.1V/DIV if a 10:1 divider probe is used.

- ☐ 3. Place S2 in the 10Hz position. A 10 Hz square wave should be present on oscilloscope screen.

- ☐ 4. Select 1Hz and 0.1Hz on S2 and check for both corresponding square wave outputs.

If problems arise recheck wiring of S2 and associated wiring to the Printed Circuit Board. If problems still exist, refer to the Troubleshooting Chart.

This concludes the construction, calibration and checkout of your 60 HZ OPTION of the Time Base Generator.

Post Calibration. Disconnect the power supply and oscilloscope. Install cover.

TROUBLESHOOTING CHART

CONDITIONS	POSSIBLE CAUSE	TIME BASE OPTION	60 HZ OPTION
LED does not light	Check F1 LED wired backwards +5 and GND wired backwards Power supply connected backwards Defective DS1	☐ ☐ ☐ ☐ ☐	☐ ☐ ☐ ☐ ☐
F1 blown	+5 and GND wired backwards Power supply connected backwards IC/IC's mounted backwards Power supply voltage too high CR4 mounted backwards Solder bridge	☐ ☐ ☐ ☐ ☐ ☐	☐ ☐ ☐ ☐ ☐ ☐
10MHz oscillator does not function (no output at pin 11, IC9)	Check associated oscillator circuit for proper parts location and solder bridges (IC9) Replace IC9 Replace Y1	☐ ☐ ☐	
No output from TP7 with S1 in external position	S1 wired incorrectly Check jumper from pin 2 hole to pin 3 hole of IC9 location Check associated input amp circuit for proper parts location and solder bridges (Q1-Q4 and IC8) Replace Q4	☐ ☐ ☐	☐ ☐
No output at "L" (pin 3 IC8)	Check for proper installation of IC8-9 Check solder connection in the area of IC8 and IC9 Replace IC8 and/or IC9	☐ ☐ ☐	☐ ☐ ☐
No output at "M" (signal present at L)	Check that R ₀ and R ₉ are jumpered to GND terminal Check associated divider circuit for proper location and solder bridges (IC1-7) (IC1-3) Recheck proper wiring of buss matrix	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
No output at "J3" (signal present at M)	Check IC8 for proper installation Check for solder bridges around IC8 Check wiring of S2	☐ ☐ ☐	☐ ☐ ☐

REFERENCE MATERIALS

For additional information on TTL circuits, you may refer to all or part of the following books:

1. TTL DATA BOOK (Radio Shack) RS Cat. No. 62-1370
2. TTL Cookbook (Howard W. Sams & Co. Inc.)
3. SEMICONDUCTOR REFERENCE HANDBOOK (ARCHER) RS Cat. No. 276-4000

4. Logic Design with Integrated Circuits (John Wiley & Sons, Inc.)
5. DIGITAL ELECTRONICS FOR SCIENTISTS (W. A. Benjamin, Inc.)
6. Another source of reference information is your public library.

Buss Matrix Diagrams. We are including additional buss matrix diagrams of the TIME BASE GENERATOR Project Board for you to use as aids if you decide to design your own divider circuits.

DESIGNING WITH THE 277-115 TIME BASE GENERATOR

The buss matrix in your TIME BASE GENERATOR Project Board enables you to use the Type 7490/7492 IC's to their maximum usages. There are five buss matrix diagrams included which allows you to design your own divider circuit. The National TTL DATA Book (Radio Shack Catalog Number 62-1370) is an excellent source for gaining complete understanding of the 7490/7492 IC's. Once you have this understanding, you can try your own design. An example is given showing how to use the schematic and buss matrix diagrams.

Example: Suppose you have a 4 MHz frequency source that you want to divide down to 1 Hz. If you can divide the 4 MHz to 1 MHz, then you can use type 7490 IC's to divide the 1 MHz to 1 Hz. A study of the count sequence for the RS 7490 IC in the Radio

Shack TTL DATA Book shows that B_{OUT} will do this if the sequence would go to count 3 and reset at count 4, starting the count sequence again. If you notice, there are two unique conditions that will aid you in doing this. At count 4, the C_{OUT} is high. Studying the reset truth table will show that when R₀(1) and R₀(2) are both high, the 7490 IC resets to "0". Therefore, by connecting the C_{OUT} to R₀(1) and R₀(2) will give us our desired circuit. The B_{OUT} will count to 3 but on the 4th count, the decade counter will reset, starting the count over again. You will get one pulse out for every four pulses you put in.

Now that we have thought out the design, let's refer to Figure 19 and draw the schematic wiring of the type 7490 IC used in the divide-by-four mode.

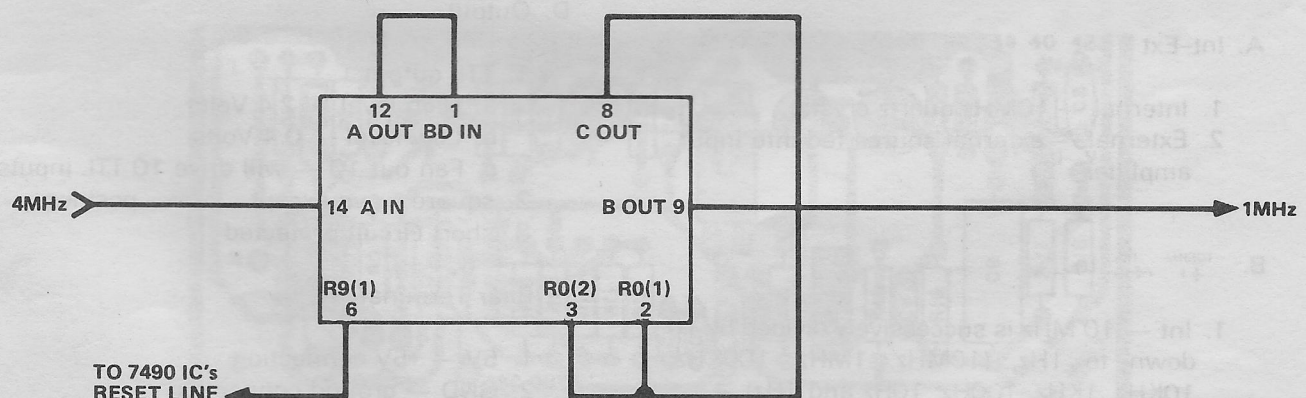


Figure 19. Schematic Wiring of a 7490 IC Divide-By-Four Mode

Go to the schematic diagram of the Time Base Generator to make a list of the following jumper connections:

- ☐ L to H2 and H3 to F3 (this jumpers the 4 MHz input to pin 14).
- ☐ E4 to G4 and E6 to G6 (jumpers pin 12 to pin 1).
- ☐ F1 to D4 and D4 to C5 (connects pin 8 to pins 2 and 3).
- ☐ D6 to B6 (connects R₉ to 7490 IC reset lines).
- ☐ E2 to E12 (connects B_{OUT} to B_{INPUT} of the next 7490 IC).

NOTE: Those of you who will be doing your own designing or your own applications, note that the counters may be permanently placed in their count mode by wiring the buss matrix as shown on pages 16, 17 and 18; and additionally connecting jumpers from B1 to D1 and W to X. You'll find this extremely useful when you are using the TIME BASE GENERATOR Board in conjunction with other logic.

SPECIFICATIONS

Power Supply Requirement: 5V $\pm$ 5% @ 300 mA or greater
 Ripple 50 mV peak-to-peak maximum
 Line regulation: 2% minimum
 Load regulation: 2% minimum

277-102 or 277-112 (adjusted for 5V) are recommended.

Mode Description.

A. Int-Ext

1. Internal — 10MHz quartz crystal
2. External — external source fed into input amplifier

B. $\frac{10\text{MHz}}{\div 1}$, $\frac{1\text{M}}{\div 10}$, to $\frac{1}{\div 10\text{M}}$

1. Int — 10 MHz is successively divided by 10 down to 1Hz, (10MHz, 1MHz, 100KHz, 10KHz, 1KHz, 100Hz, 10Hz and 1Hz).
2. Ext — any external source from 1Hz to 10MHz can be divided from 1 to 10 million in succession of 10 ($\div 1$, $\div 10$, $\div 100$, $\div 1\text{K}$, $\div 10\text{K}$, $\div 100\text{K}$, $\div 1\text{M}$ and $\div 10\text{M}$).

- ☐ Now transpose the above connections onto the buss matrix diagram. Now the matrix diagram example can be a guide for wiring the jumpers. Please note that when jumpers cross that these jumpers should be insulated by using insulated wire. Refer to Figure 20 for example of buss matrix jumper wiring for a divide-by-four mode of a 7490 IC.

The remaining 7490 IC's should be wired as in the symmetrical divide-by-tens as in the main option of the Time Base Generator. This completes our design.

For circuits of your own design, you must determine circuit application and develop your own calibration and troubleshooting data.

C. External Input

1. Frequency range
 - a. 1Hz to 30 MHz in $\div 1$ position
 - b. 1 Hz to 10 MHz in all other positions
2. Maximum input level:
 - a. DC to 40 Hz 150V (dc + peak AC)
 - b. 40 Hz to 1 MHz 150V RMS
 - c. 1 MHz to 30 MHz 5V RMS
3. Sensitivity
 - a. 100 mV (RMS sinewave) 10 Hz to 1 MHz
 - b. 200 mV (RMS sinewave) 1 MHz to 30 MHz
4. Input Impedance
 - a. $1\text{M}\Omega$
 - b. 50pF maximum

D. Output

1. TTL output
 - a. High level — 2.4 Volts
 - b. Low level — 0.4 Volts
 - c. Fan out 10 — will drive 10 TTL inputs.
2. square wave except $\frac{10\text{MHz}}{\div 1}$ position
3. short circuit protected

E. Rear Terminal

1. 5V — +5V connection
2. GND — ground connection
3. R₀ — reset to zero (requires hi for rst)
4. R₉ — reset to nine (requires hi for rst)

F. Crystal Oscillator — accuracy $\pm 0.1\%$

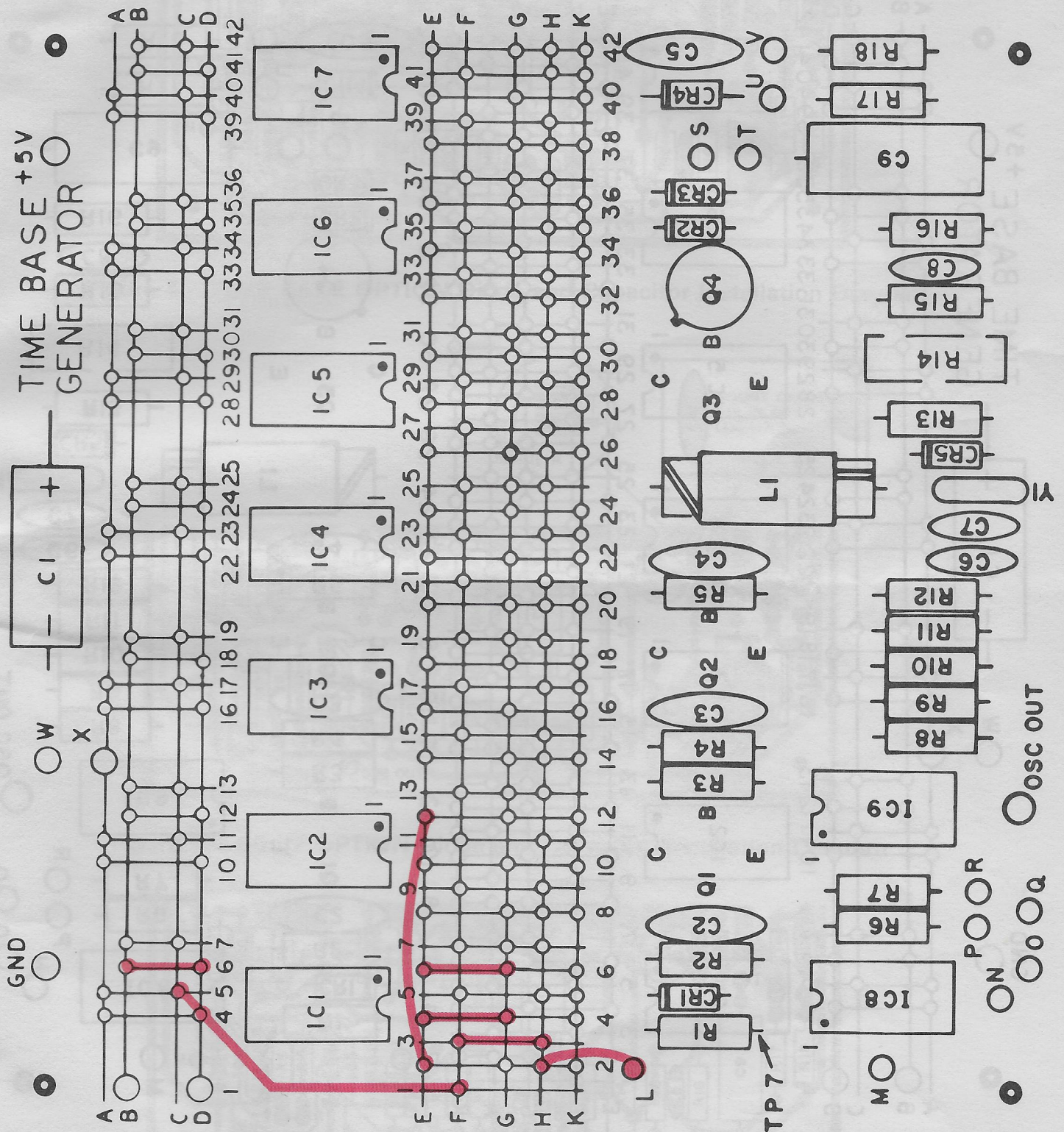
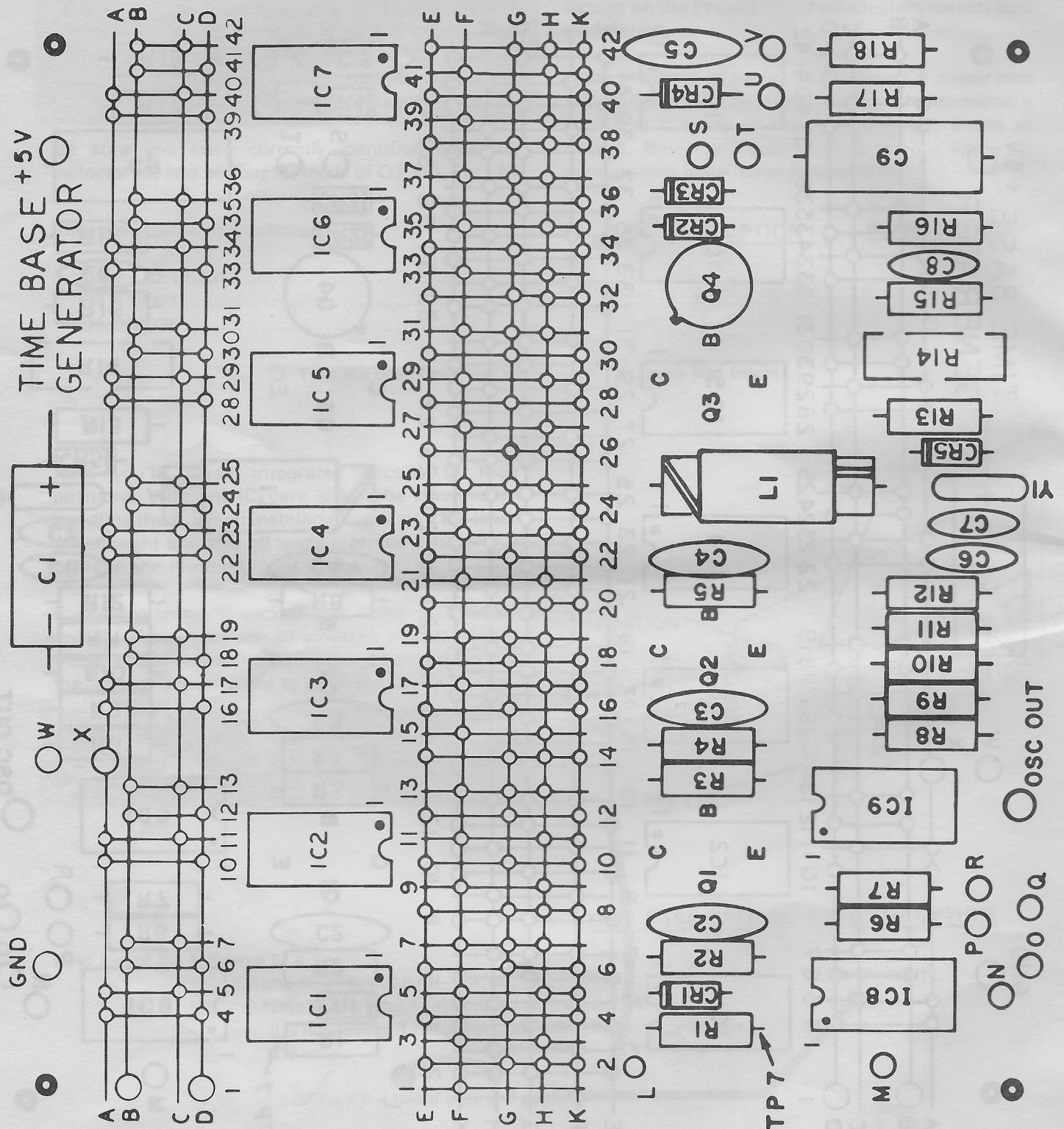
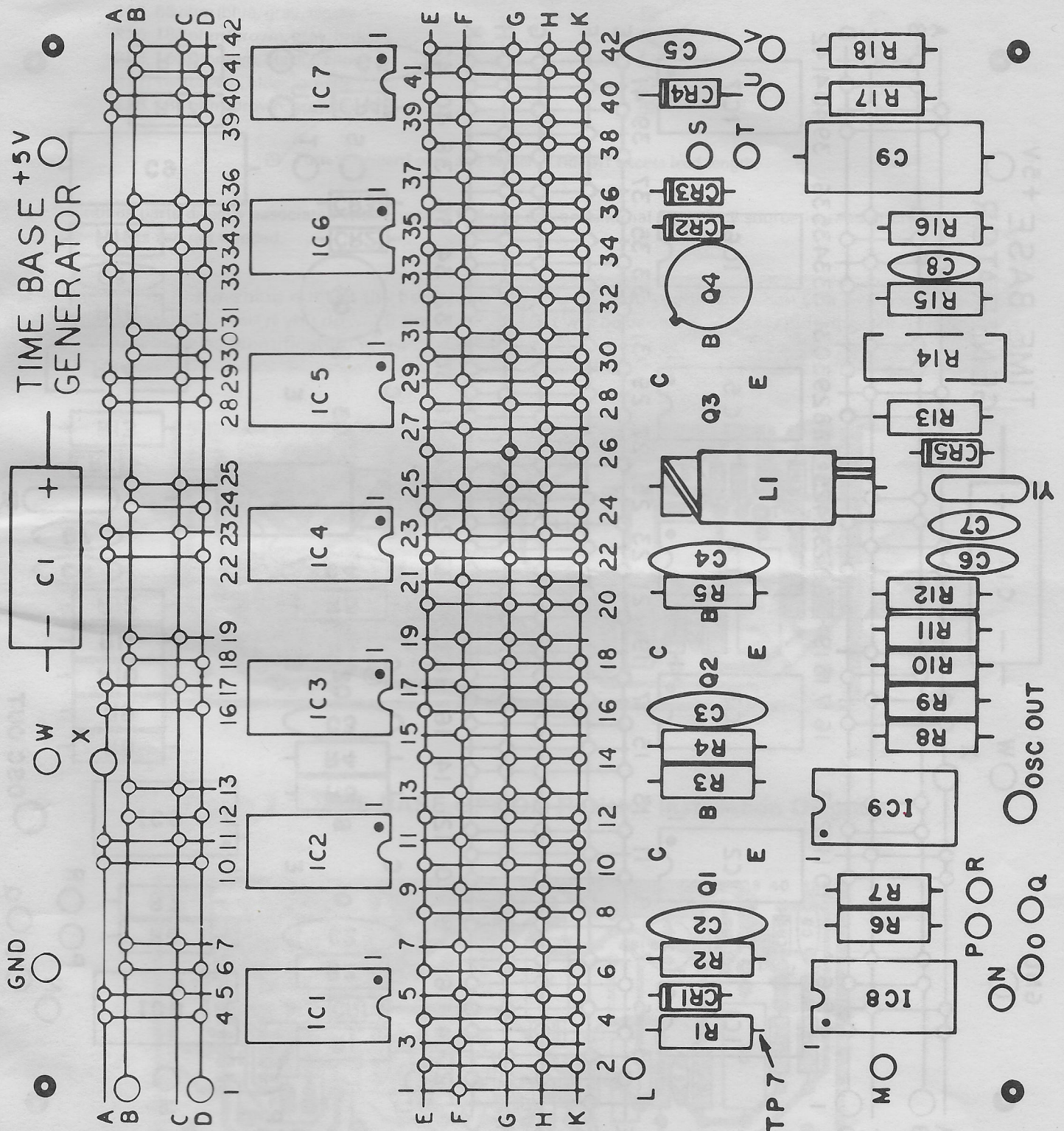
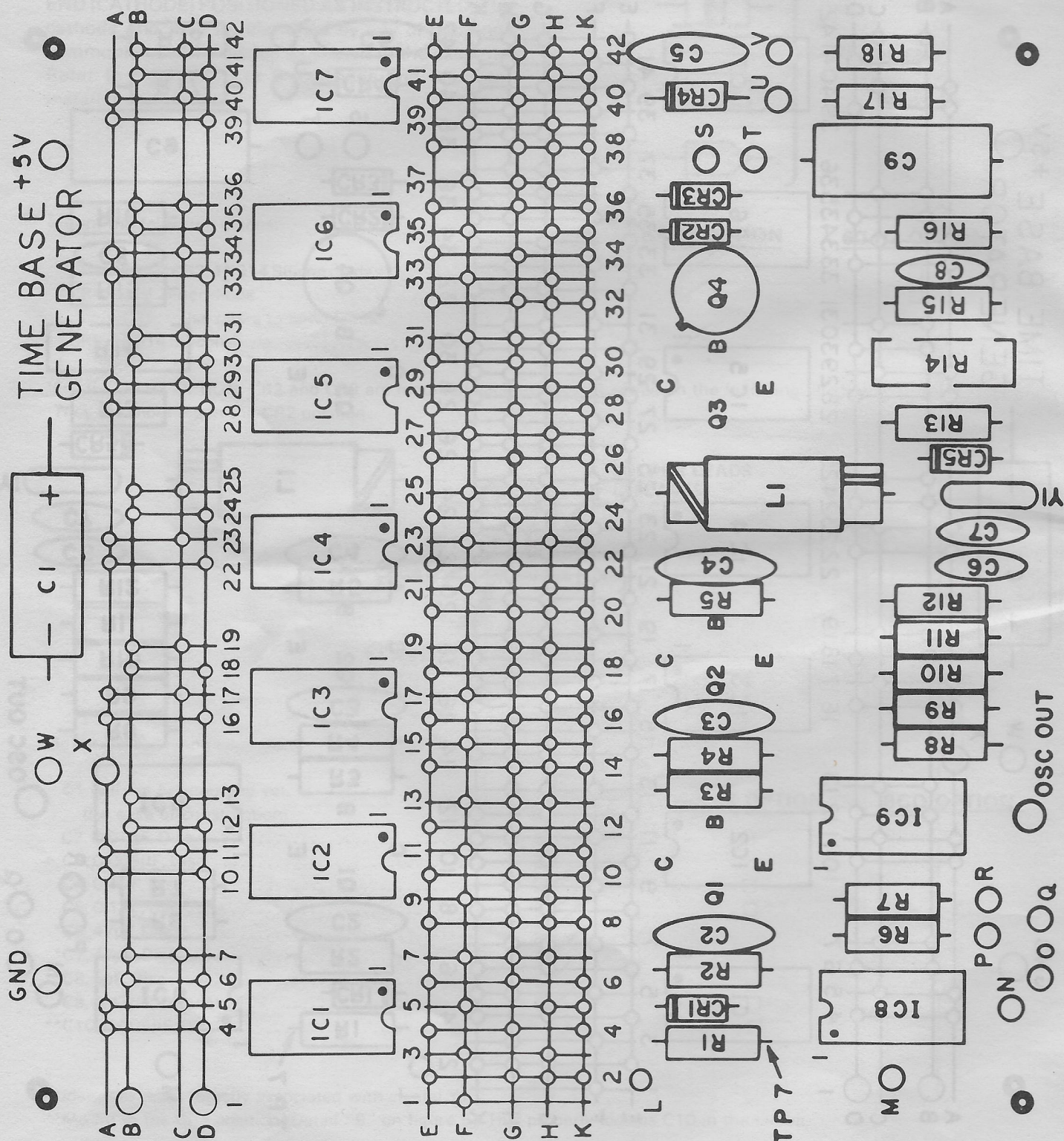
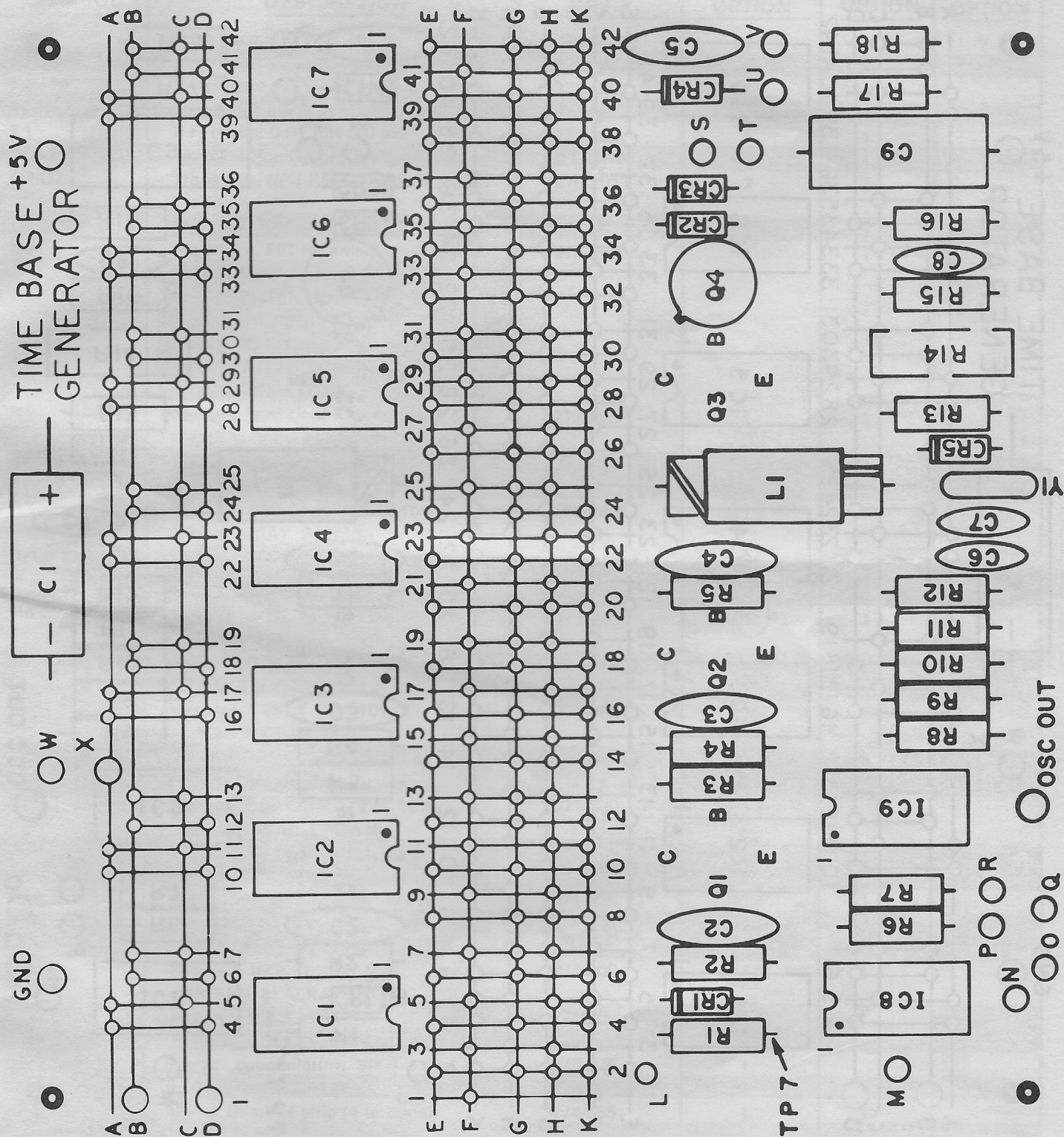


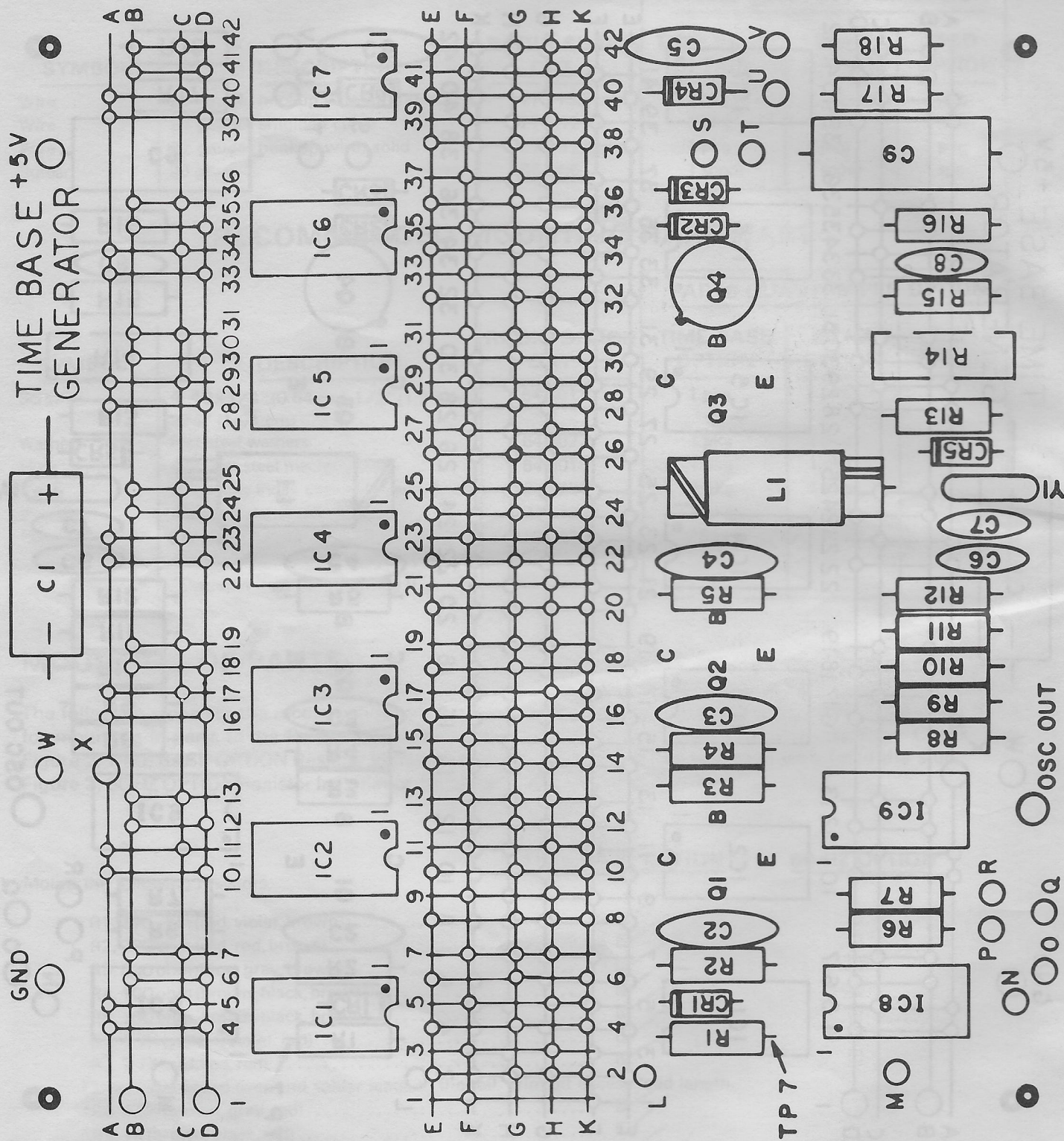
Figure 20. Example Of Divide-By-Four Jumper Wiring Installation











ALL WAVEFORMS TAKEN WITH 200MVRMS, 1MHz INPUT SIGNAL, DC COUPLED, THROUGH A 10:1 DIVIDED PROBE—OSCILLOSCOPE SETTINGS ARE GIVEN WITH EACH WAVEFORM.

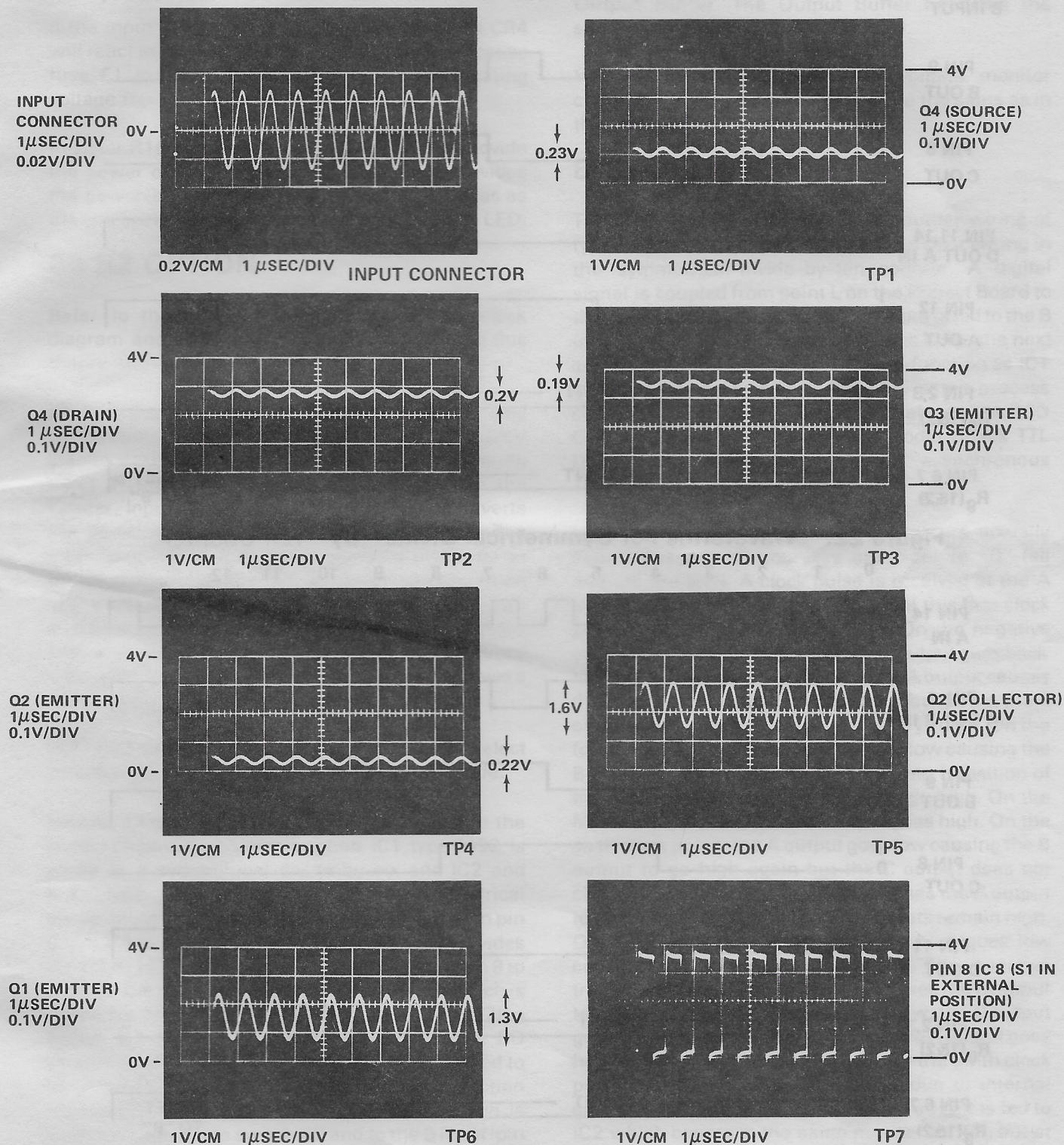


Figure 21. Typical Waveforms

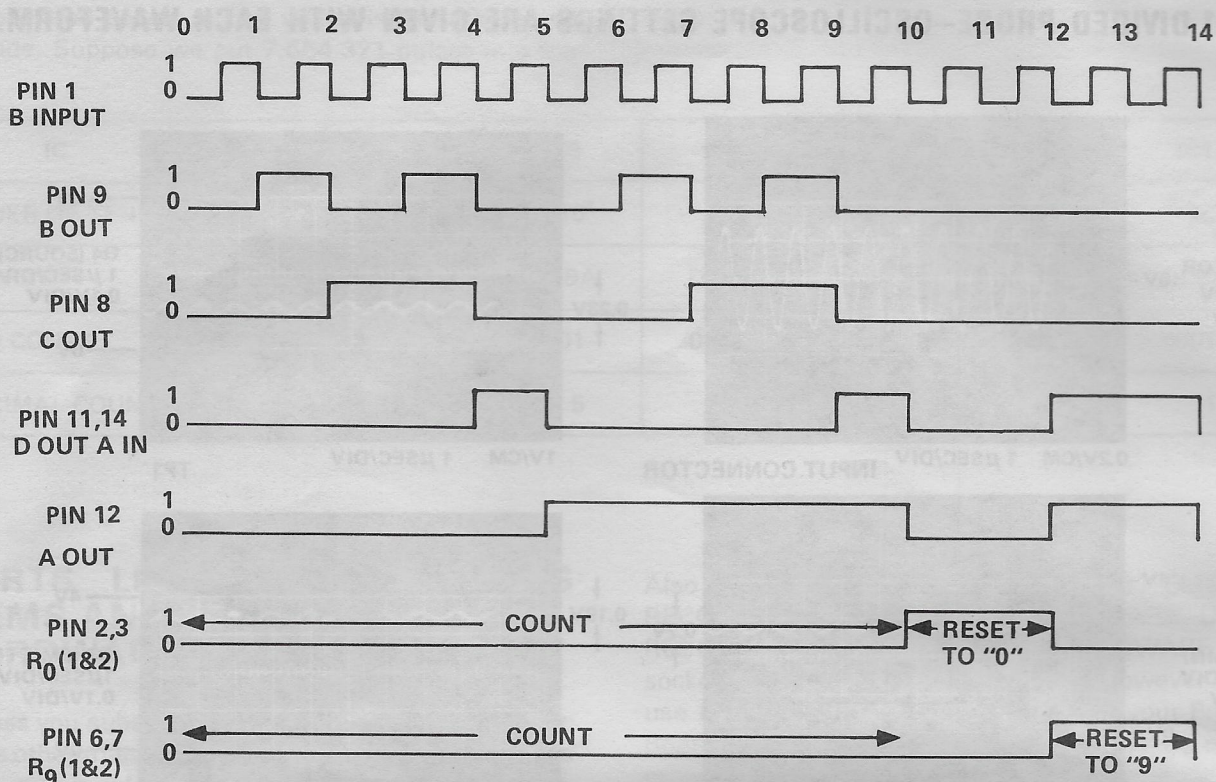


Figure 22. Waveforms For Symmetrical Divide-By-Ten Counter

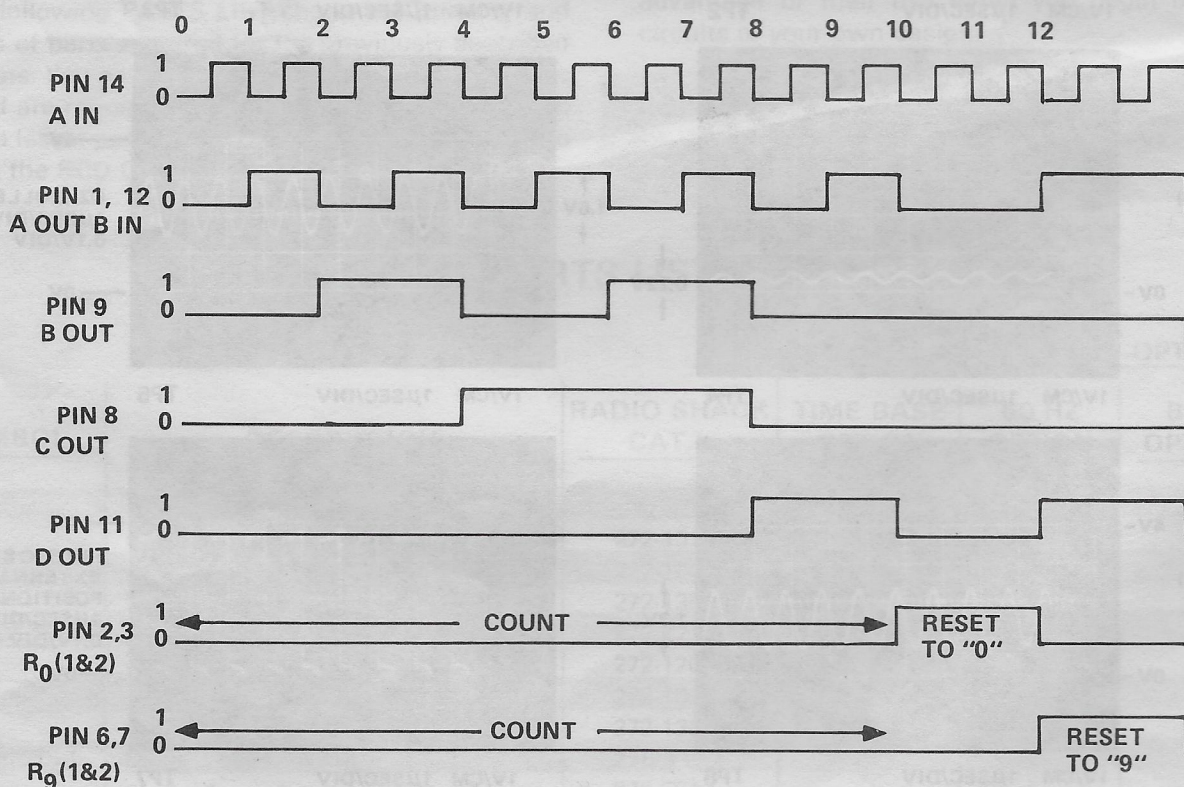


Figure 23. Waveforms For Binary Coded Decimal Decade Counter

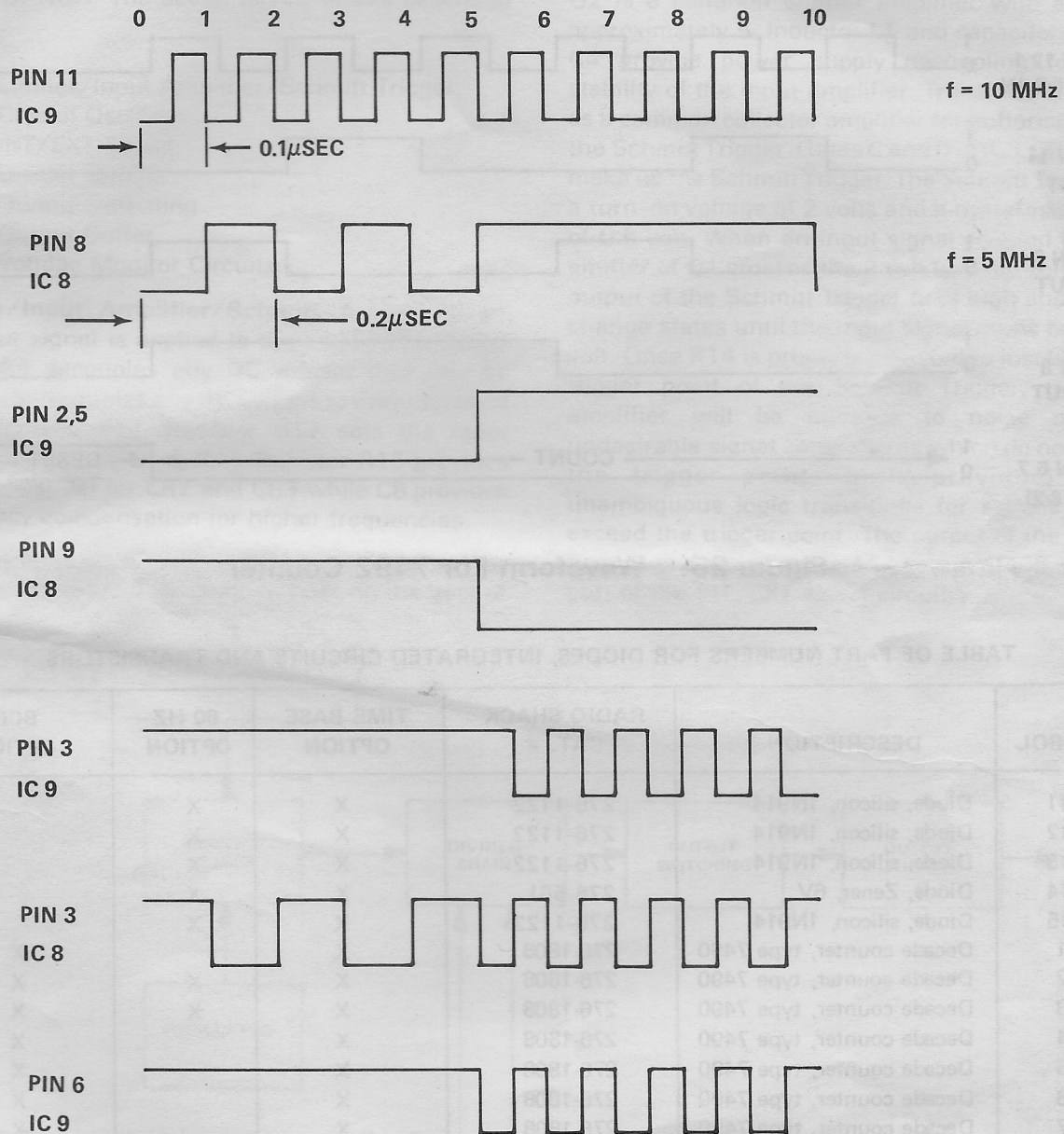


Figure 24. Waveforms for AND-OR Invert Gate

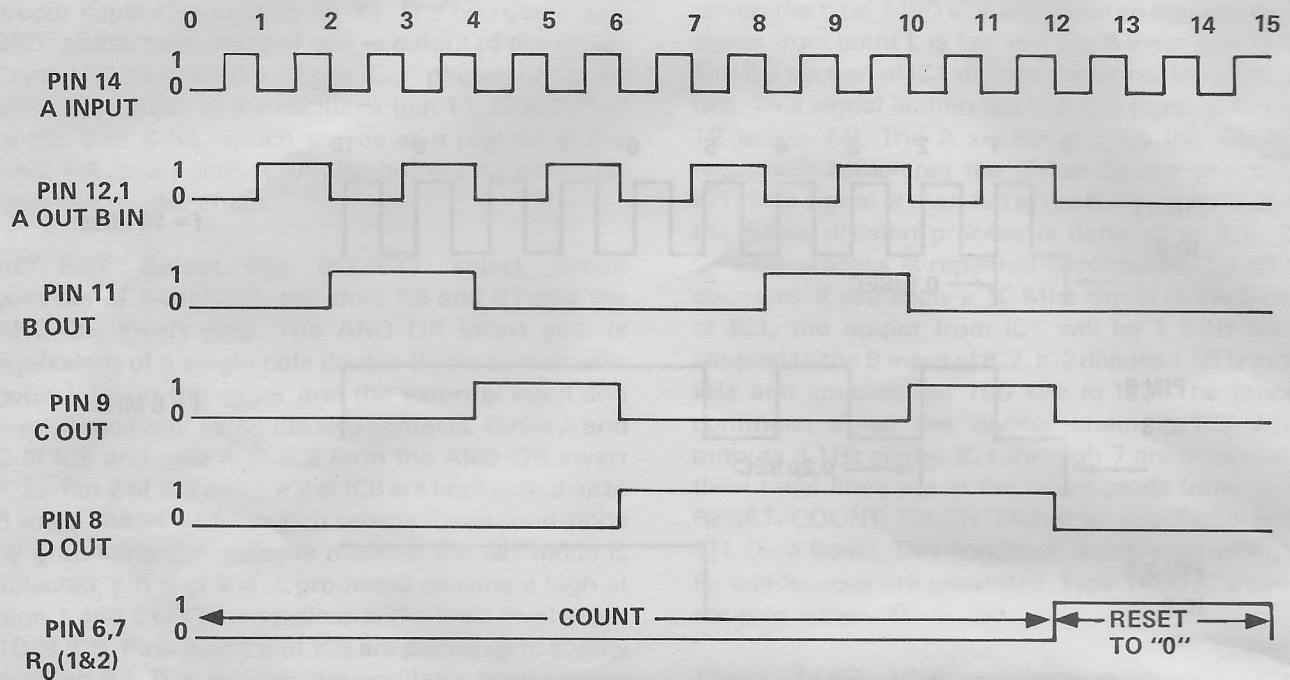


Figure 25. Waveform For 7492 Counter

TABLE OF PART NUMBERS FOR DIODES, INTEGRATED CIRCUITS AND TRANSISTORS

SYMBOL	DESCRIPTION	RADIO SHACK CAT. #	TIME BASE OPTION	60 HZ OPTION	BCD OPTION
CR1	Diode, silicon, 1N914	276-1122	X	X	
CR2	Diode, silicon, 1N914	276-1122	X	X	
CR3	Diode, silicon, 1N914	276-1122	X	X	
CR4	Diode, Zener, 6V	276-561	X	X	
CR5	Diode, silicon, 1N914	276-1122	X	X	
IC1	Decade counter, type 7490	276-1808	X		X
IC2	Decade counter, type 7490	276-1808	X	X	X
IC3	Decade counter, type 7490	276-1808	X	X	X
IC4	Decade counter, type 7490	276-1808	X		X
IC5	Decade counter, type 7490	276-1808	X		X
IC6	Decade counter, type 7490	276-1808	X		X
IC7	Decade counter, type 7490	276-1808	X		X
IC1	Divide-by-twelve counter, type 7492	276-1819		X	
Q1	Transistor, NPN RS2011	276-2011	X	X	
Q2	Transistor, NPN RS2011	276-2011	X	X	
Q3	Transistor, PNP RS2021	276-2021	X	X	
Q4	Transistor, FET RS2036	276-2036	X	X	

TIME BASE GENERATOR

Catalog Number: 277-9115

ADDENDUM FOR EUROPEAN 50 HZ VERSION

This Addendum accompanies the Instruction Manual for 277-115 (North American/60 Hz version). With only minor variations and notes you can build a Time Base Generator with a Line Frequency/Counter option for 50 Hz.

Throughout the Manual where reference is made to 60 Hz (as used in North America) you should change to 50 Hz if you intend to follow the changes noted below for the 50 Hz Line Frequency Option.

You'll note that the 10 MHz Time Base Crystal is supplied with this ProjectBoard.

Note the following changes in your Manual (for 50 Hz option):

Page 2, Right Column, second paragraph from the bottom. Add following to this paragraph:

"The 10 Hz output is available, **but will NOT be a square wave.**"

Page 5, Left Column, last paragraph.

IC1 will be type 7490 (**not** 7492) for 50 Hz and "is wired as a symmetrical divide-by-ten" (rather than divide by six).

Page 7, Parts List for "50 Hz Option" (not 60 Hz).

IC1-7 (7490) should be 3 (**not** 2) for 50 Hz.

IC1 is replaced by a 7490 as noted above (delete here).

Y1 10 MHz Crystal is included with this ProjectBoard.

Page 14, First Step. For the 50 Hz option, change this step to read:

"IC-1 Divide-by-Ten Counter RS7490"

Page 18, For 50 Hz Option, add the following new jumper step:

"☐ F5 to K5"

Note: This step is not included in Figure 12; you might want to add it to Figure 12 in your Manual.

Pages 29 to 31, Calibration Procedures. Note that the TANDY CORPORATION Catalog Numbers for the external Power Supplies are:

277-9102 and 277-9112

Page 31, Step 3 at the bottom of the page.

The 10 Hz waveform will not be a square wave (it will be symmetrical, but not square).

TANDY CORPORATION

AUSTRALIA

280-316 VICTORIA ROAD
RYDALMERE, N.S.W. 2116

BELGIUM

PARC INDUSTRIEL DE NANINNE
5140 NANINNE

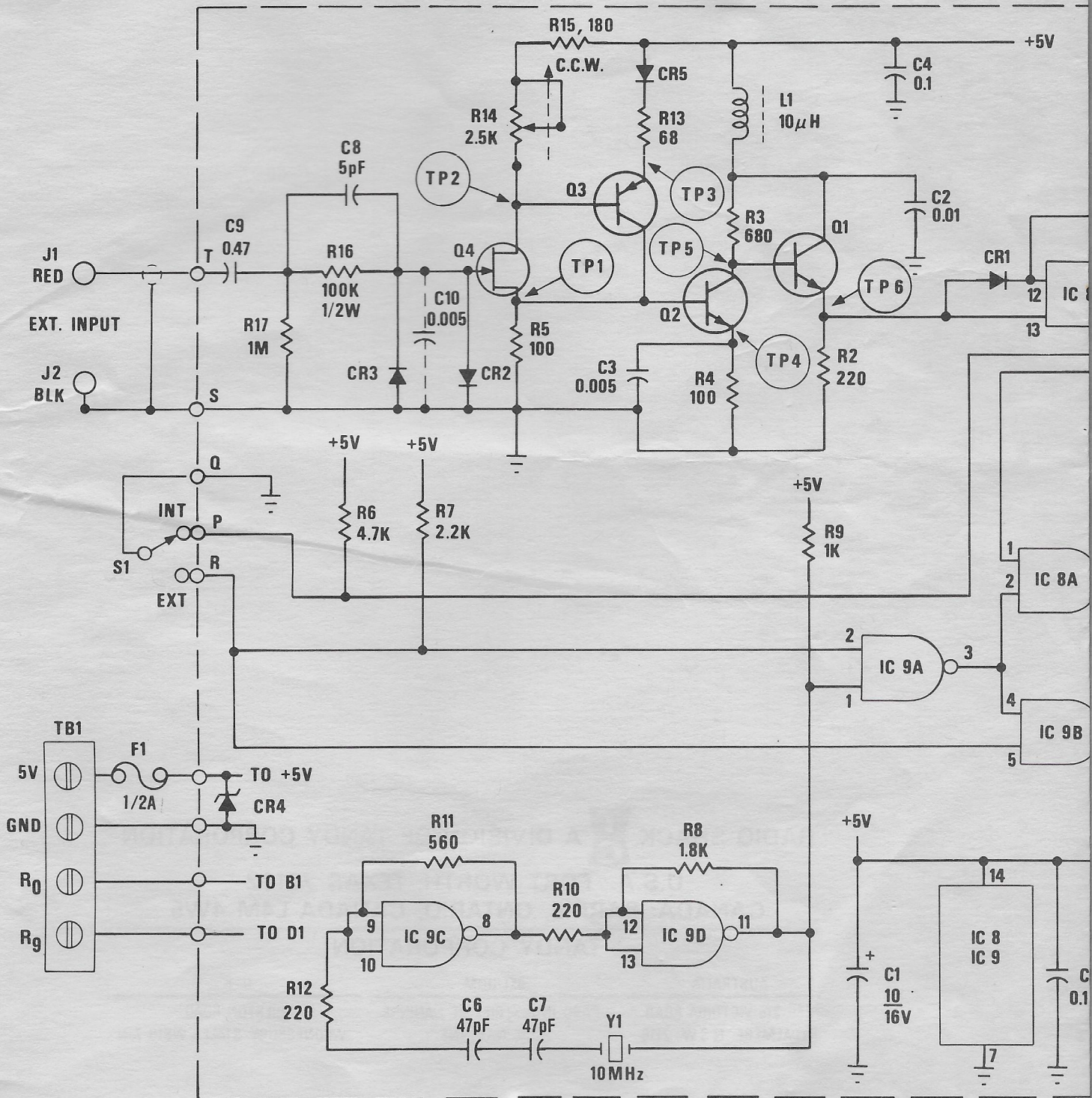
U.K.

BILSTON ROAD, WEDNESBURY
WEST MIDLANDS WS10 7JN

Printed in U.S.A.

NOTES: UNLESS OTHERWISE SPECIFIED

1. ALL RESISTORS ARE 1/2W.
RESISTORS VALUES ARE IN OHMS (K = 1000).
2. ALL RESISTORS HAVE 10% TOLERANCE
3. EXCEPT FOR R16 AND POTENTIOMETER R14, 1/4W,
5% RESISTORS RS CAT. NO. 271-1300 MAY BE
SUBSTITUTED FOR THE 1/2W, 10% RESISTORS.



4. ALL CAPACITORS ARE IN μF . (pF = PICO FARAD)
5. C10 USED WITH 60Hz OPTION ONLY.

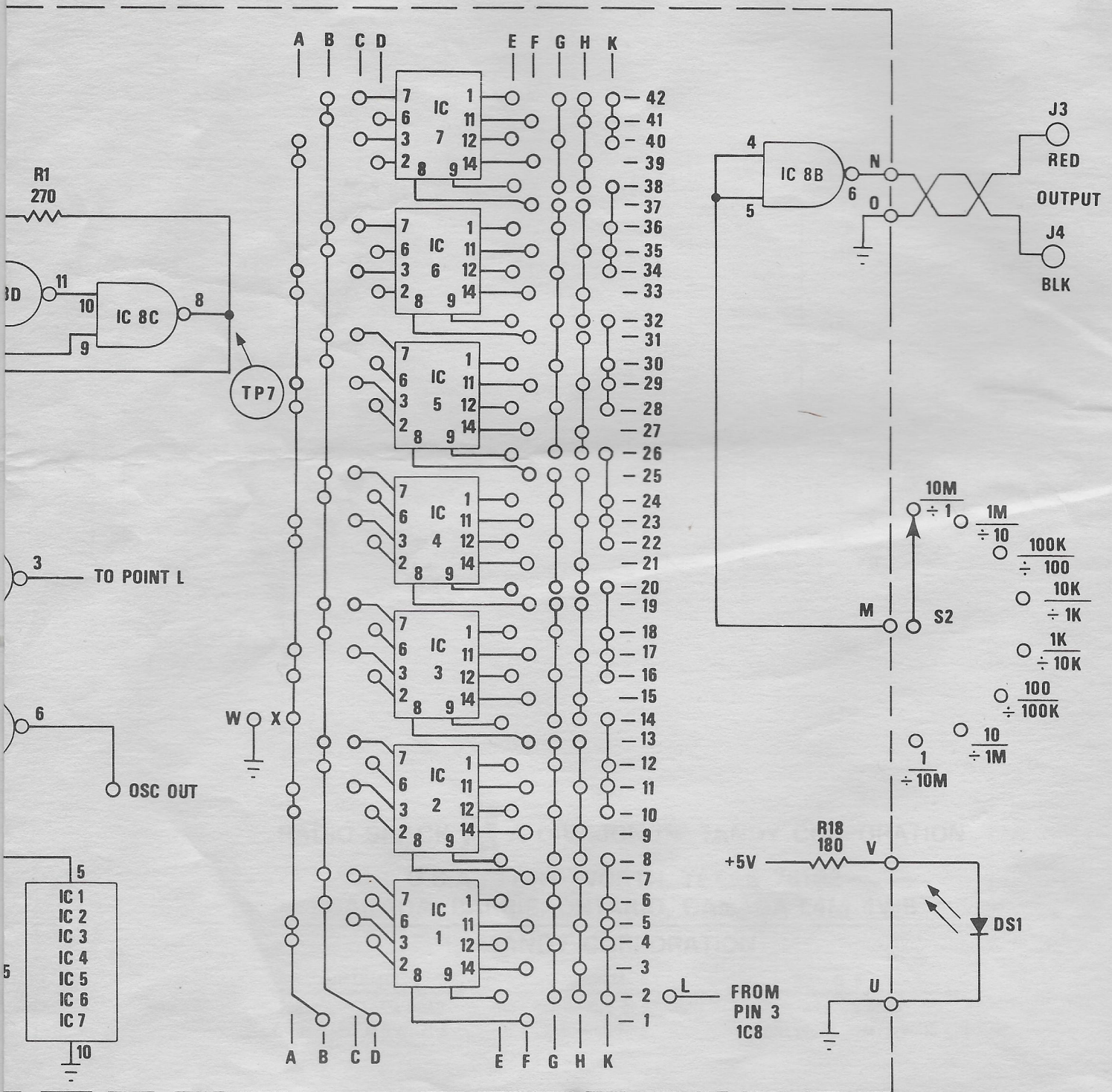


Figure 26. Schematic Diagram of TIME BASE GENERATOR

RADIO SHACK  A DIVISION OF TANDY CORPORATION

U.S.A.: FORT WORTH, TEXAS 76102

CANADA: BARRIE, ONTARIO, CANADA L4M 4W5

TANDY CORPORATION

AUSTRALIA

280-316 VICTORIA ROAD
RYDALMERE N.S.W. 2116

BELGIUM

PARC INDUSTRIEL DE NANINNE
5140 NANINNE

U. K.

BILSTON ROAD
WEDNESBURY, STAFFS WS10 7JN